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Journal of the
AMERICAN STATISTICAL ASSOCIATION

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American Statistical Association

Organized November 27, 1839
Incorporated 1841

The American Statistical Association is a scientific and educational organization. Its membership is not confined to professional statisticians but includes economists, business executives, research directors, government officials, university professors, and other persons who are seriously interested in the application of statistical methods to practical problems, in the development of more useful methods, and in the improvement of basic statistical data. Engineers, mathematicians, biologists, actuaries, sociologists, psychologists, and representatives of many other professions are included in the membership of the Association. Information about the Association and membership application forms may be secured from the Secretary, Lester S. Kellogg, 1603 K Street, N. W., Washington 6, D. C.

Chapters of the Association have been organized in important cities in the United States and in Havana, Cuba. Information concerning the meetings of these Chapters may be secured from the District Representatives listed on another page.

The Editors welcome the submission of articles and notes for possible publication in the JOURNAL. Manuscripts should be sent to the Editor, Journal of the American Statistical Association, 1603 K Street, N. W., Washington 6, D. C. Books for review should be sent to the Review Editor, Glenn E. McLaughlin, 1603 K Street, N. W., Washington 6, D. C. Authors who wish suggestions about the preparation of manuscripts and charts or information about editorial policies should address their inquiries to the Editor.

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JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION

Number 229 MARCH, 1945 *Volume 40*

THE ROLE OF THE AMERICAN STATISTICAL ASSOCIATION*

By Helen M. Walker
Teachers College, Columbia University

THREE YEARS have passed since the members of the American Statistical Association last came together in a national gathering. The Annual Meetings of 1942 and 1943 were relinquished chiefly because of the demands upon wartime transportation facilities, relinquished willingly in recognition of the compelling immediacy of the demands of war, but relinquished with full awareness that the Association and any influence the Association may have would not be strengthened by such action. The justification for holding a national meeting this year, while transportation is still over-taxed, resides in an earnest conviction of the Board of Directors as to the contribution of statistics to the public weal and the responsibility which rests upon the American Statistical Association for furthering that contribution. Even the most casual reading of the program for this Annual Meeting will indicate that it mirrors a concern for the increased efficiency and unity of the entire statistical profession and for its more effective service to the welfare of society.

Early in 1944 the Board of Directors decided that every possible effort should be made to hold a national meeting this year, and that it should be so planned as to focus attention upon the relation of statistics to the formation of policy and on the contribution of a professional association of statisticians in promoting that relation. It is a matter of gratification to every member of the American Statistical Association that the Vice President of the United States is a man who thinks statistically and who understands the contribution of statistical investigation as basis for rational decision. That we were able to prevail upon him to speak at this dinner is an honor of which all of us are deeply sensible.

* Presidential address at the 104th Annual Meeting of the American Statistical Association at Washington, D.C., December 27, 1944.

At a time like the present when almost everyone is trying to foresee the nature of the world which lies ahead and to dedicate his best intelligence to promoting the welfare of that world, it is inevitable that a national gathering of statisticians should face the question of what contribution the American Statistical Association might be expected to make toward the general wellbeing of society. I have not been able to escape this topic, nor do I want you to be able wholly to escape it. An association is strong and useful in proportion to the amount of creative thought which its members devote to its activities.

Members of the American Statistical Association presumably have this in common: they recognize in the complex problems of our very complex world a statistical aspect of which the non-statistician is unaware; they believe that it is desperately urgent that for such problems correct and pertinent statistical information be secured and thoroughly studied before decisions are made; they are convinced that much of the important work in the natural and the social sciences, many aspects of government, commerce and industry are incomprehensible to persons unfamiliar with certain fundamental statistical ideas; they believe it is of the profoundest importance to secure a more effective application of statistical logic in the solution of the world's problems. Therefore it seems obvious that the conscious purpose of the Association must be to facilitate in every way possible the most informed, effective, intelligent application of statistical methods to those problems in government, in jurisprudence, in public administration, in the sciences, in business, commerce, industry, education, finance, for which the evidence that should be taken into account is stochastic in nature.

To realize this objective, many kinds of interrelated services must be performed. Those persons now holding statistical positions must be given the utmost stimulation to good work which an active professional association can devise. The future must be safeguarded by attracting young people of promise to the profession, giving them the best possible training, and helping them find appropriate positions. Both the art and the theory of statistics must be extended and means found to disseminate more widely the results of recent research. Ways must be found to make the general nature of statistical thinking better understood by the average intelligent citizen and particularly by persons in responsible positions charged with policy formation. Committees of the Association will continue to render distinguished service to the government by making available expert and disinterested advice, as has been done for many years, and doubtless such cooperation will be extended to new areas. It is to be hoped that more local chapters of the

Association will develop service to their state and community governments similar in purpose to the work of those committees of the national body which now work with the federal government. And as instrument to these ends, there must be a strong professional association with an efficient structure and resources of personnel adequate to work effectually toward its recognized purposes. The Association needs to move on all these fronts at the same time. In particular, a many-sided program of interpretation seems to be called for. Certain aspects of interpretation in which the Association has been long engaged I shall say little about this evening, not because they are unimportant but because their importance, being generally recognized, needs no underscoring, and it is more expedient to put our attention upon other aspects of interpretation where a new or more determined effort appears to be needed.

No one can doubt that there has been a vast proliferation of statistical enterprise during the war. It is well known that the extension of statistical activity has far outstripped the available supply of workers who are competently trained, either in the mathematical theory of statistics or in the arts of statistical procedure; that agencies have been bidding against agencies for even mediocre persons if they can claim a little training in statistics; that the shortage of college teachers of statistics would have been alarming had it not been paralleled by an even greater shortage of students. Obvious as the critical shortage of trained statisticians has been to all persons concerned either with the conduct of statistical activity or the teaching of statistics, it has probably not made a profound impression upon the college administrator. Unless the American Statistical Association brings this shortage to the attention of persons responsible for college programs and also to the attention of prospective students, we need expect no sudden burgeoning of the statistical curriculum and no spontaneous increase in the number of talented young people seeking statistical careers.

Some day I hope the American Statistical Association may be instrumental in recording and publishing the statistical story of these war years, the magnitude and scope and variety of the statistical studies undertaken, the new methods developed, the frantic search for trained statisticians to man the various important enterprises, the fateful decisions which were made as a result of statistical information, perhaps also those decisions which were made without the benefit of statistical advice or even in defiance thereof. Obviously it is still too soon to record this story, too many things are still "confidential" and the chief protagonists in the vast enterprise are still too heavily bur-

dened to be diverted from their more immediate tasks. Ultimately, when pressures relax a little, the organization of this record would do much to stimulate the profession and also to inform the thoughtful public and thus to create a climate of opinion more favorable for the progress of statistical investigations.

Fully as striking as the current increase in statistical activity is the expansion of the mathematical theory of statistics which has been rapidly gaining momentum in recent years. To anyone who reads even the titles of papers in the theoretical journals it is obvious that here is a development of tremendous vitality, power, and far-reaching significance.

Every major statistical idea has two natures, two faces. There is the world of mass phenomena, apprehended by the senses, in which at first acquaintance chaos appears to reign. Variation from individual to individual, from sample to sample, appears to be the one universal and inescapable fact. Yet underneath the apparent confusion the acute observer detects a measure of uniformity, there are discernible patterns in the way these individuals fluctuate, there are relationships which dominate the swarming inconsistencies, there are limits beyond which uncertainty does not pass. There is also an abstract world of definitions, postulates and proofs, quite distinct from the sensory universe of stochastic phenomena. The abstract structures of this latter world form mathematical models which at certain points appear to match the sensory phenomena in much the same way that a road map matches the countryside. Without the services of the mathematical map maker, the sensory phenomena cannot be satisfactorily explored. Without the compelling pressure of practical situations demanding exploration, the mathematical theory might develop in abstract sterility, beautiful, complete, but useless. The competent research worker must have acquaintance with both worlds, else he is likely to assume a false parallelism between his concrete data and some convenient but inapplicable mathematical pattern. But very few statistical workers are fully at home both in the concrete data of a substantive field and in the mathematics upon which statistical theory depends.

Therefore one of the tasks of interpretation which I believe the American Statistical Association should assume is that of closing the gap which now seems to separate the man who considers himself a theorist from the man who considers himself a practical statistician. We must find a way of persuading some of the clearest thinkers among the mathematical group to write really outstanding expository papers clarifying the more fundamental logical ideas and describing and illus-

trating the more important new techniques, omitting mathematical proofs but giving references to sources in which they can be found. I use the word "persuading" because the present dearth of such obviously valuable papers seems to imply that this is not the kind of writing which people do for their own recreation. If pointing out the urgent need of such articles is not enough, then the Association must devise other incentives to secure them—such as special publications, a section of specially invited papers in the JOURNAL or an annual lecture series.

The rapidity of the expansion of statistical theory makes such expository papers continually more essential. A few years ago, one who devoted a large proportion of his time to the serious study of statistics could expect to read most of the important papers in the field. Now we appear to be entering an era when theory expands so fast that no one who does much work of his own can hope to find time to read all the significant contributions of other writers. Even among mathematical statisticians an increasing amount of specialization may be inevitable in the not-too-distant future.

Perhaps we may also find a way to bring to the attention of that relatively small group of persons who are creatively extending the mathematical theory of statistics some of the problems which the creative practitioner feels need theoretical attention. The extension of the theory itself does not seem to me to be the province of the American Statistical Association, but providing a means of communication through which various members of the statistical guild, with diverse talents, may better understand each other, so that they may wholeheartedly work together and so that our whole profession may unitedly serve our day and generation—that seems to me to be one of the chief reasons why there should be an American Statistical Association and why it is worthy of the devoted service of its members.

We may hope that the notable expansion of statistical activity and the impressive clarification of statistical logic to which I have referred will entail a greater respect for statistical thinking on the part of the general public and an increased willingness on the part of legislators to be guided by statistical analyses but we certainly cannot take that outcome for granted. We have not yet reached that happy era described by M. G. Kendall in an address to the Royal Statistical Society "when the man in the train who begins his remarks with 'of course, I am not a statistician,' does so with a sense of humility and not, as at present, with an air of quiet satisfaction at freedom from a serious mental disfigurement."

Although a research worker in any branch of science needs statistics

as a research tool and as a logical pattern for thought, the science curricula in our universities seldom require the study of statistics until a late stage of specialization is reached, if they require it at all. Had he been exposed to a good general course in statistical method in the early part of his college career, many a scientist would have seen reasons for seeking thorough training in statistical method and would not need to spend the rest of his life bemoaning his inability to read fundamental research papers in his own field.

Over fifty years ago, Florence Nightingale writing to Sir Francis Galton made an eloquent plea for "some teaching how to use statistics in order to legislate for and to administer our national life with more precision and experience," and commented that "though the great majority of Cabinet Ministers, of the Army, of the Executive, of both Houses of Parliament have received a university education, what has that university education taught them of the practical application of statistics?" In 1944 it is still an unusual lawmaker who consults scientific rather than political oracles.

Here then is another major need of interpretation, the interpretation of the purposes and general nature of statistical investigation to the non-statistician. If executives overrule the recommendations of their statistical research bureaus it is relatively unfruitful to blame the executives, we will do better to try to find ways to educate them. If the public fails to value and support statistical research, we must take some of the blame ourselves in that we have failed to insist that the nature of statistical thinking is an appropriate topic for inclusion in a liberal education.

We may well ponder the relationship between the remarkable discoveries made in the physical sciences in recent years and the increased popular interest in scientific topics, noting that certain of the greatest of scientists have considered it worth their while to serve as interpreters of scientific research to the layman. Their willingness to share with the public as much of scientific information as the public could grasp has helped to create a general readiness to support scientific research, an increased demand for the services of trained scientists, and sometimes even an over-valuation of the possibilities of scientific inquiry. In contrast to the worker in the physical sciences, the statistician is still popularly misunderstood and the outcome of statistical studies too often misprized.

Even as the great scientists have exercised a stimulating and regenerating influence upon the scientific education of the non-scientist, it is time for the leading statisticians to put serious thought upon the

statistical education of the non-statistician. One medium for such education might be articles couched in non-technical language, addressed to the intelligent layman, and appearing in non-statistical periodicals, such as the article on Quality Control published by *Fortune* in October of last year.

A general college education is designed to help its possessor understand the modern world and adjust himself intelligently to it, but I have never heard of a liberal arts college that undertook to explain to its students the stochastic nature of the universe in which they live and move and have their being, or even to assist them to acquire certain general and very simple but very important statistical concepts. It would seem highly appropriate for the American Statistical Association to call this matter to the attention of college administrators.

Let us look briefly at some of the statistical ideas needed in his personal life by the intelligent individual who never expects to do even the simplest statistical work.

The ability to read simple graphs and tables is now widely accepted as an essential part of a general education and is taught in almost every Junior High School. Nevertheless college students habitually skip over the graphs and the tables in their texts. In this vital aspect the arts of communication appear to be incompletely mastered.

The approximate nature of all measurement should be taught in the secondary school but seldom is. This is a pity, for it is easy to devise simple experiments which will make the inescapable unreliability of measurement unforgettable even to immature students, and will even give them the concept of a frequency distribution of errors of observation.

The universality of human variability is an important concept which if more widely recognized would spare much individual anxiety. A very common fallacy which has extremely bad social consequences is the assumption that if the mean of group A is considerably larger than the mean of group B every individual in group A must exceed every individual in group B. Vast possibilities for social mischief are inherent in that mistake, especially when it is made the basis of discriminatory practices affecting all members of a group. Concomitance is so ubiquitous a phenomenon that the statistician is likely to suppose it is ubiquitously understood. If however he listens attentively for a few hours to the conversation of a group of college graduates innocent of statistical training, he can usually pick up a fairly choice collection of boners. They confuse concomitance with causation. They express surprise that where a high relationship has been noted some individual

departs from the group trend. They are troubled when the offspring of brilliant parents appear less brilliant than those parents. They think a child who has the highest I.Q. in his group should be expected to stand highest in all other traits and is to be censured if he does not. Even without the computation of a single coefficient of correlation, much could be done to correct this kind of unintelligent thinking.

The idea that the examination of a relatively small number of randomly selected individuals can furnish dependable information about the characteristics of a vast unseen universe is an idea so powerful that only familiarity makes it cease to be exciting. To many laymen it still looks like legerdemain. They tend either to draw positive conclusions from a single case or to suspect the evidence from a random sample of, say 1000, on the ground that "only a thousand cases is a very small proportion of the whole population." Yet only rarely does any person get through a single day without encountering some form of sampling. Here indeed is a dilemma. The statistician is aware that real understanding of statistical inference comes only through years of study and is aghast at the temerity of trying to tell the layman anything about it, and so the layman goes on daily making erroneous judgments about practical affairs. Unfortunately those practical affairs are not always the private concern of the man himself. Sometimes they are your affairs and my affairs and the affairs of all citizens. The man to whom no one in college tried to teach anything about sampling may later become the chairman of an important committee in one of the state governments or in the federal government and he may insist on a complete enumeration when an inquiry by sample would have cost far less and would have made all the needed information available more speedily. Or he may block the investigation altogether. Could a cultural, non-technical undergraduate course have helped him? Certainly it could. It could show him the practical difference between biased and representative samples and could help him to become aware of subtle sources of bias in his own special field. Participation in drawing a series of random samples from a known population could give him some idea of how the various statistics of those samples fluctuate about the population values, what a standard error is, how the sampling distribution takes form, that not all statistics have the same form of sampling distribution, and that the variability of the statistic shrinks as sample size is increased. It could make vivid to him the idea that generalizing from a sample to its population involves uncertainty, but only a limited and predictable amount of uncertainty. The two risks of error in testing a statistical hypothesis have their counterpart in his everyday experi-

ence. He should understand that the conscious study of these two risks is one of the unique aspects of statistical method, is something which no other system of thought attempts.

Where the teachers of such classes could be obtained is the chief problem. While the instruction I am discussing would be almost devoid of mathematics, it can certainly not be given by one who knows nothing of the underlying theory. The teaching of classes in which the emphasis is primarily cultural is intrinsically far more difficult than the teaching of classes in which the emphasis is professional. I can only repeat my earlier statement that we must move on many fronts at one time, and ultimately there will be available a supply of teachers not only for technical but also for cultural instruction.

Another kind of interpretation which may be usefully undertaken by a professional association is that of helping workers in one substantive field become acquainted with methods developed in other fields. In earlier days, most of the members of the American Statistical Association came from the fields of economics and sociology. Now, however, the Association is receiving more and more members with major interests in public health, in psychology, in the natural sciences, in quality control, in mathematics, in education, and it will thus acquire both greater opportunity and greater responsibility for this kind of cross fertilization among its own members. In addition we should consider thoughtfully the opportunities for collaboration with other professional associations in fields in which statistics is an important research method but not the chief focus of interest. Such collaboration may take the form of joint committee action on some project to which our group can render special assistance in the methods of investigation; or it may lead to a more inclusive, more permanent, more structural pattern of cooperation among a group of national societies with statistical interests. Preliminary steps leading in this direction will be reported tomorrow, but I want now to say that I believe a federation or consolidation or structural pattern of cooperation among national statistical organizations so that they can effectively act as a single body will further the purposes we have been discussing.

And now let us consider the inner health of the American Statistical Association itself, for a strong organization is needed to serve its own members and society adequately. The American Statistical Association needs a better structural pattern in order to function efficiently. Initial steps have been taken to effect such improvement and a constitutional amendment intended to facilitate change will be presented at the business meeting. The Association would be greatly strengthened if its

membership were increased to include most of the persons actively engaged in statistical work in America. It is a safe guess that if our present members would make it their business to recommend their eligible colleagues and associates, our numbers could be quickly doubled, perhaps trebled.

If the Association is to exert its maximum influence, it must have strong roots in local communities, must develop strong chapters which are a potent influence for the improvement of state and local statistical activities. There must be a close working relationship between chapters and parent association by means of which each reinforces the other.

The strength of a professional organization is the responsibility of every individual member thereof. Is he willing to accept committee responsibilities even when they are personally inconvenient? Is he enough interested in the development of the organization to put his mind to work on its problems, to volunteer ideas, to attend business as well as program sessions, to read and think about an annual report? We can have an association so strong and so effective that it raises to a new level the opportunities for statisticians and the prestige of their profession, but only if enough of us put constructive effort into its activities.

Again returning to my original thesis concerning the objective of the American Statistical Association, I shall close with a quotation from George Sarton's biography of the great Belgian statistician, Adolphe Quetelet, who was the first foreign member of the American Statistical Association:

> I like to think of the constant presence in any sound Republic of two guardian angels: the Statistician and the Historian of Science. The former keeps his finger on the pulse of Humanity, and gives the necessary warning when things are not as they should be. The Historian of Science—or let us say simply the Historian (for in the future every historian will have enough scientific training to appreciate the importance of science)will not allow Humanity to forget its noblest traditions or to be ungrateful to its greatest benefactors. If the Statistician is like a physician, the Historian is like a priest,—the guardian of man's most precious heritage, of the one treasure which, whatever may happen, can never be taken away from him —for the past is irrevocable. Humanity must be protected by the watchful Statistician, and it must be sustained in its newer and bolder efforts by the consciousness of every antecedent effort, to which it owes its culture, its dignity and its excellence.

THE USE OF STATISTICS IN THE FORMULATION OF A NATIONAL FULL EMPLOYMENT POLICY*

By the Honorable Henry A. Wallace
Vice President of the United States

Each statistician can well remember when he or she first began definitely to use statistics for a specific purpose. I, myself, first became intrigued with statistics in the calculation of corn-hog price ratios back in 1915. A little later the problem of using multiple correlation coefficients to determine the relationship between summer rainfall and temperature, on the one hand, and corn yields on the other hand, resulted in a paper which the Weather Bureau was kind enough to publish in 1920. In December 1923 I presented a paper before this Association on the determination of hog prices by hog supplies and business activity. The statistical aspects of Fisher's quantitative theory of money intrigued me and in 1920 I became one of the vice presidents of the Stable Money League. This brought me into contact with Carl Snyder and Randolph Burgess of the New York Federal Reserve Bank. Carl Snyder strongly believed in aristocratic capitalism and endeavored to prove in every field of human activity that the dispersal of human ability followed the Pareto distribution curve. I believed in both economic and genetic democracy and therefore Carl Snyder and I would have many a long argument whenever we got together at the time of these annual statistical and economic gatherings.

I have also found myself interested in the quantitative approach in political analysis. About 1928 Carl Snyder began to develop his statistical method of forecasting elections. In 1936 Louis Bean, working independently, developed his method, and I followed the analyses of both very closely in comparison with the sampling surveys that Gallup and Roper started.

In the election campaign this year, I had an opportunity to merge economic forecasting with political forecasting. The evening of October 28 I heard over the radio the President's Chicago campaign speech and immediately sent him a wire saying, "Your goal of sixty million jobs is perhaps high but I glory in your daring and, as you say, America can do the seemingly impossible. We are predicting you will carry thirty-six states and have a three million popular majority."

The President wired back on November 1 that he was glad I liked the Chicago show and that he promised to make good on the sixty

* A paper presented at the 104th Annual Meeting of the American Statistical Association, Washington, D.C., December 27, 1944.

million jobs if I would do the same with regard to my predictions concerning the thirty-six states and the three million popular majority.

History will record that something was done toward the formulation of economic policy for this country in that interchange of statistical wires. In practically every campaign speech I made from November 1 onward I would tell my audience about this interchange of wires and then say, "The President has put me on the spot. I've got to make good on this election prediction and I want you to help me." In some of the extemporaneous speeches I think I even went so far as to say, "If you will vote for Roosevelt you help get me off the spot and put him on." The people smiled at the joke. Seriously speaking, the President in his address to Congress last January 11th and again in his Chicago October 28th campaign speech, referred to his economic bill of rights. This bill of rights must be translated into legislative action. That's what the vote meant on November 7. Item number one on the economic bill of rights is "the right to a useful and remunerative job in the industries or shops or farms or mines of the nation."

Full employment in the United States is the first step on the road to permanent world wide peace. Other nations look at the tremendous economic power of the United States, at the violent fluctuations in the American business cycle, at the previously demonstrated ineptitude of the American government in dealing with the problem—and, after seeing all this and looking toward the future, they shudder and pray. They pray for full employment in the United States, not because they love the United States, but because they know that without full employment here there is worldwide trouble.

Without full employment here we undermine world price levels and world trade, the results of which reach into the economic and political fabric of every other country. Without full employment we cannot have a successful foreign economic policy of reduced trade barriers and a high volume of both exports and imports.

In the next session of Congress one of the first bills to be introduced will no doubt be the Full Employment Bill of 1945, designed to carry out item number one on the economic bill of rights. This bill or some other bill dealing with full employment will, in my opinion, become even more significant for the future than the agricultural bills which Congress wrestled with in the twenties. "Equality for agriculture" was the farmers' battle cry beginning in 1924. That which gave definitive striking power to the phrase, "Equality for agriculture," was a statistical price concept worked out by Hugh Johnson and George Peek back in 1921. They presented this concept to Harding's agricultural confer-

ence in January of 1922 but it was not put in legislative form until 1924.

The abstract concept of justice in terms of prices was given a mathematical formulation by the young economic statisticians in the Department of Agriculture in the middle 1920's. As the years went on the idea of parity price more and more gripped the imagination of farm leaders. I well remember the exultation in the voice of George Peek when the concept of justice for agriculture was written into the preamble of the farm legislation back in May of 1933.

For worker, businessman, farmer, and above all for the statesman interested in preventing the hardships which create revolution in other countries, the concept of jobs for all is even more important than price "Equality for agriculture." Farmers are much better off with price equality and full employment than they are with price equality and unemployment. In other words, a medium piece out of a big pie of consumer purchasing power may be a whole lot larger than a large piece out of a small pie. What the economic statesman wants is the biggest possible pie for the whole world in order that all the nations, all the regions and all the groups may have a good slice.

"Jobs for all" should and will be the economic battle cry of all the peoples of the world for the next twenty years. A phrase of this sort is good as a political slogan but if it is ever really to amount to anything in the life of the Nation it must have a statistical formulation of some kind. Somebody must do for the economy as a whole what General Johnson and George Peek did for agriculture when they worked out the underlying statistics of the phrase, "Equality for agriculture."

Impetus recently was given to the coming battle for full employment by Jim Patton, President of the Farmers' Union. I didn't learn the story from Jim Patton or from any Farmers' Union member. A government statistician told me how Patton, pondering on the role of investment for a post-war gross national output of 200 billion dollars, was impressed by the Simon Kuznets national income data. Here he found that over any ten-year period about twenty per cent of the total volume of goods and services produced in this country was represented by so-called "capital formation." As I understand it, gross capital formation as used by the statisticians in the Department of Commerce and the National Bureau of Economic Research consists of new construction of all kinds, including buildings, roads, and plant and equipment, for both replacement and expansion. In 1929, when there was substantially full employment, these items amounted to around twenty billion dollars and the total national product of goods and services was around a hundred billion dollars.

In order to have full employment after the war, Jim Patton reasoned that it would be necessary to have a total product of two hundred billion dollars at present prices and wages, and therefore an annual expenditure on capital goods amounting to around forty billion dollars. He was anxious to stimulate discussion and hoped the forty billion dollar figure would serve that purpose. Patton was a friend of Senator Murray of Montana who also was Chairman of the War Contracts Subcommittee. He therefore submitted to this subcommittee a rough draft of a legislative measure designed to have the government provide for a forty billion dollar level of capital investment every year. The subcommittee forwarded this proposal to the various government agencies. Some of them assumed that Patton meant to rely on the generating power of capital investment as the sole source of economic activity. Others felt the forty billion figure did not necessarily represent the precisely correct amount of investment which might be necessary to secure full employment in any given year, and some felt that fiscal policy, wage levels, foreign trade, and other matters should also be dealt with. As a result of these criticisms the original draft was broadened.

Its present form is the proposed Full Employment Bill which was brought forcibly to public attention by newspaper stories on December 18. When both the *New York Times* and *PM* give a bill a big front page play on the same day, there must be something to it. The President's figure of sixty million jobs and Senator Murray's Full Employment Bill of 1945 have in them great thought-provoking power. I am sure there are many improvements which must be made in the phraseology and content of the proposal but the Murray bill does have the supreme merit of focusing attention on the key spot.

I know many of the statisticians and economists here in the various agencies who have in recent years developed the basic data on the national income and have been drawing up patterns of national expenditure and income for full employment. This bill capitalizes on this constructive work.

This is not the occasion for any detailed discussion of the legislative, administrative and economic features of this bill. In brief, the bill declares it to be the national policy to secure as much employment as possible through private enterprise and in addition provide for sufficient desirable government programs to insure the jobs necessary for all who want to work. It calls for setting up an annual Nation's Budget for jobs in addition to the annual Federal Budget. It calls for estimating the number of jobs needed during the ensuing year or years to provide

full employment, and for estimating the gross national product or total expenditures at the expected level of prices by business, consumers, and government required to provide that total number of jobs. It further calls for estimating the prospective volume of investment and other expenditures by business, consumers and government including expenditures in foreign trade. In case the prospective expenditures are likely to fall short, government is directed first to encourage increased private employment, and then, if necessary, a general program of increased Federal expenditures to make up the difference, these expenditures to include assistance to business, useful public works, public services for health, education, slum clearance, conservation and development of natural resources and other programs.

I find in this proposed bill something that has hitherto been lacking in most of our postwar planning: Namely, a clear understanding of the necessity for active interplay between the executive and the legislative branches of our Government. The bill recognizes the key role of the Congress in determining our basic national policies. At the same time it provides a method of dramatizing economic programs, of raising to the level of "high politics" the economic deliberations of our President and of the members of our Senate and House of Representatives. Under this bill, there would inevitably be basic disagreements between various political groups as to how much emphasis should be put upon measures to stimulate private enterprise and how much emphasis upon direct Federal investment. There would inevitably be conflicts between the President and many vocal groups in the Congress. In actuality, the common man would have no guarantee of his right to a job unless he were politically organized to see to it that his President and his Congress adopted those specific policies and those specific programs that would actually assure full employment. Which is just as it should be.

Under the bill, however, if the wrong policies are adopted, it would be infinitely easier for the average man and the average woman to point the finger at the political leader or the political group responsible for those policies. In short, the proposed National Production and Employment Budget would provide a method of political accountability to the people of our country—a yardstick by which the common man could measure the extent to which he has been properly served by his representatives in the Government.

With the bill in operation, both government and business would be under the necessity of informing the public much more promptly of forthcoming fiscal policy. Business for its sake needs prompt information as to government policies. Likewise government needs prompt in-

formation as to future investment plans of business. The bookkeeping of future investment in both fields can be of the greatest value in molding government policies and removing business uncertainty. Specifically, I think that the Full Employment Bill might well be amended to provide that tax measures are always to be enacted by June 30th of each year, so that business can know in advance what the fiscal policy of the Government is really going to be.

If the President, as the proposal provides, were to set up a Nation's Budget along these logical lines, and if, as the proposal further provides, this budget were to be submitted for detailed study by a new Joint Congressional Committee on the Budget, I can foresee considerable extension in the use of the national statistics now available, and the development of a great deal more information on production, employment, incomes and consumption by regions and by industrial and occupational groups. In a hasty survey of government statistics required and available for estimating requirements of the proposed Full Employment Bill, made for me by Dr. Stuart Rice, I find that a bill of this sort would lead to filling up certain statistical gaps which must be filled up if unemployment is to be anticipated and prevented. Above everything we must have a more adequate basis for estimating in advance the volume of investments, current and prospective, by business, by consumers and by governments.

These inadequacies and gaps in our statistical information should not deter us from making full use of what we have in relation to emerging economic policy. I have always been a believer in exact and complete data, but much progress in policy making can be made by the use of statistics for operating purposes that may be only 80 to 90 per cent complete.

Statisticians and economists, working on national income and national expenditures, seem to be moving in the same direction in various parts of the world. For example, the same line of thought contained in the Full Employment Bill, is emerging also in both England and Australia. In both these countries we find the same emphasis on the public responsibility for maintaining a high level of general purchasing power; and the same concern with the three chief sources of expenditures for funds and services—namely, the consuming public, private business and government. There is even emerging a common pattern in the statistical lingo and in the handling of the basic facts with regard to consumers' purchases, business investment in plant and equipment, and government expenditures for ordinary administrative purposes, for war purposes, and for developmental purposes.

Sir William Beveridge has just published a report on "Full Employment in a Free Society" which I think transcends in importance his masterpiece on Social Security two years ago. Social Security programs, desirable as they are, constitute a minor part of the total stream of purchasing power required to sustain a high level of production and employment. I quote two paragraphs from Beveridge's new book. The first deals with responsibility, the other with the means through a new type of budget.

Bear in mind that this report is based on long study of British prewar and war experience. With regard to state responsibility Beveridge says:—

> Employment depends on outlay. Full employment cannot be attained unless outlay in total is sufficient to set up a demand for the whole of the labour that is available for employment. . . . During war a large part of the total outlay is undertaken directly by the State. During peace the bulk of the outlay can, and in a free society will, continue to be private. But the ultimate responsibility for seeing that outlay as a whole, taking public and private outlay together, is sufficient to set up a demand for all the labour seeking employment must be taken by the State, because no other authority or person has the requisite powers. No private enterprise can survey the whole field of industry or ensure at all times a demand for all that industry can produce at a price covering its costs. No private enterprise can make finance its servant rather than its master. The outlay of every person or authority other than the State is limited rigidly by the financial resources of that person or authority. The central proposition of this Report is that the responsibility of ensuring at all times outlay sufficient in total to employ all the available man-power in Britain should formally be placed by the people of Britain upon the State. That first and foremost is what is meant by adopting a national policy of full employment.

So much for the Beveridge ideas on governmental responsibility.

With regard to the new type of budget, he says the following:

> The instrument by which the State has influenced outlay in the past has been the annual Budget presented, usually about April of each year, by the Chancellor of the Exchequer. This Budget has determined directly the scale of public outlay undertaken by the Central Government; it has to a very large extent determined the outlay of local authorities; by the taxation proposed it has influenced both the extent and the direction of outlay by private citizens. It is through the same instrument of public outlay and of taxation that the State in future must pursue its new objective of adequate total outlay. Adoption of a national policy of full employment means a revolution in national finance—a new type of Budget introduced by a Minister who, whether or not he continues to be called Chancellor of the Exchequer, is a Minister of National Finance.

In Australia the head of their Ministry of Postwar Reconstruction, Dr. H. C. Coombs, has adopted very much the same approach. In a

recent lecture on "Problems of a High Employment Economy" he states that

> The appropriate policy of Goverment would appear to be as follows:
>
> (a) to determine a basic public investment programme, including all works which it considers of sufficient urgency to be undertaken whatever the level of private investment;
> (b) to discover from private enterprise the scope of their plans;
> (c) if these two programmes are judged insufficient, to supplement them by:
> (i) further investment by private enterprise prepared at the request of and perhaps assisted by the government; and/or
> (ii) the inclusion of projects for public investment of lesser urgency than the basic programme already included;
> (d) to have ready numbers of emergency works which could be readily put into operation to supplement the planned programme if it proves insufficient.

As a common man, the statistician and the statesman look toward the future, they know that supreme emphasis must be placed on full use of all resources of man, nature and technology to raise the standard of living of all the world. Both the scientists and the statistician know the productive potentialities are enormous. And this knowledge must make for daring economic projections and bold statesmanship to bring them about. On the statistical side we must have the courage of certain governmental economists who, back in 1940 when most of us thought a 100 billion dollar output of goods and services was beyond the realm of the probable, cited a firm statistical base for thinking that within two years it was physically and technologically possible to raise our annual output to the present equivalent of nearly 200 billion dollars.

Almost no one believed them. The war has proved them right. Contrast their imaginative daring with the fearful, halting attitude of certain nostalgic editorial writers or with those who would have us wait until unemployment is upon us before taking coordinated, preventive measures. Not in such a spirit shall we solve the very great problems of the postwar years.

The war in Europe and in the Pacific has yet to be won and that task must continue as the first preoccupation of our hands, hearts, and minds. Nevertheless, the 79th Congress will undoubtedly carry on its shoulders full responsibility for devising full employment legislation. Looking ahead to the day when Congress sees definite signs of peace the statisticians must anticipate the types of statistics which will inevitably be required. To anticipate the Congressional need accurately the statisticians must of necessity acquaint themselves with all that the economists of the Anglo-Saxon and European world have learned

as a result of World War II and the depression following World War I. They must meet with forward looking Congressmen who are anxious to move with speed when the time comes. They must meet with those business, farm, and labor leaders who are eager to see the United States go ahead with full steam. In the economy of the future the only true national deficit will be labor unemployed and statistical terminology will be more and more concerned with the full use of our resources.

I have given you examples of very specific policy proposals made here and abroad for achieving full employment. As I have said, I am not here concerned with the administrative mechanics of a full employment policy but rather with the principles it should follow. Whether or not we formalize the Nation's Budget we must adopt the idea it represents. The essential idea is that the Federal Government is ultimately responsible for full employment and can discharge its responsibility only by planning in advance to synchronize all of its programs with the programs of private enterprise so that the whole national income will be maintained at the full employment level.

THE MEASUREMENT OF POSTWAR LABOR SUPPLY AND ITS CAPACITY TO PRODUCE*

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THE ALMOST UNIVERSAL acceptance of the postwar goal of full employment has led naturally to attempts to calculate first, the number of people who will be seeking employment, and second, the total output of goods and services if the bulk of those people should be productively employed. Without such estimates we cannot appraise the difficulties to be overcome in reaching that goal, the opportunities it would open up for business enterprise and the resulting increase in the American standard of living.

A number of these projections have been made for varying periods after the war, using different measures of employment and output and expressed in dollars at varying arbitrary price levels. The result has been a range of estimates, even among competent analysts, which is confusing to the layman.

Much of this confusion can be avoided. Measurements of the productive capacity of the postwar labor force are necessarily only rough approximations indicating the magnitude of the goal, but the basic facts are relatively simple and noncontroversial.

THE POSTWAR LABOR FORCE

The size of the postwar labor force will be determined primarily by the growth in population of working ages. A continuation of prewar trends toward increased employment of women, longer schooling, earlier retirement and other changes in the proportion of men or women seeking employment at each age level will result in some net increase, but the growth in population is the dominant element.

The actual estimating of future population is a complicated and laborious process but the basis for the estimates is clear. Since we are concerned only with the working ages, and only with the next decade or so, the future birth rate can be ignored.[1] The civilian death rate is comparatively stable. The net balance of immigration and emigration is likely to be small. Looking ahead no farther than 1950 the probable error in the estimates is not great enough to invalidate any conclusions which might be drawn from them.

Two recently published calculations will serve to indicate the nature of these conclusions. According to the estimates released by the Bureau

* A paper presented at the 104th Annual Meeting of the American Statistical Association, Washington, D. C., December 28, 1944.

[1] Of course the birth rate would have some bearing on the number of women seeking jobs.

of the Census the growth in the labor force from 1940 to 1950, before allowance for war casualties or other war influences, would be 5,866 thousand.[2] Using a different method of projecting future changes in the proportion of each age and sex group employed, Hagen and Kirkpatrick arrive at an increase of 6.2 million for the decade.[3] This again is before allowance for war influences. My own independent calculations lead to a slightly lower estimate of five and one-half millions but these calculations are less detailed and the result is not necessarily more accurate. In any event the general magnitude of the increase is clear.

Any assumption as to war casualties is necessarily a crude guess. It is usually assumed that they will reduce the postwar labor force by about half a million. This round figure allows for 2 to 3 times the losses to date. Again the probable error is not large relative to the total labor force.

Between 1940 and 1944 almost 7 million persons were added to or remained in the labor force who would not normally have sought employment.[4] They left school or college for the armed forces or were affected by the intensity of the demand for civilian labor.

Most of this "abnormal" increase will tend to disappear when the wartime conditions which brought it about no longer exist. There is no reason to assume, for example, that the war has permanently reversed the prewar trend toward longer schooling and earlier retirement. But some of the additions may be more or less permanent.

In the postwar year of full employment the demand for labor would presumably be more intense than in 1940, although much less so than in 1944. Unfortunately we do not know how many people were not counted as seeking employment in 1940 who would have been part of the labor force if sufficient employment opportunities had existed. Neither do we know how many working women in 1940 would have withdrawn from the labor market, or how many young people would have remained in school, if the head of the household had had an adequate income. Since there are no reliable data on short-term fluctuations in the labor force prior to 1940 the evidence has to do only with what has happened under extreme wartime conditions.

As an indication of the possible magnitude of the adjustment, Hagen and Kirkpatrick add 1 million to their 1950 estimate, or a net of half a

[2] "Normal Growth of the Labor Force in the United States: 1940 to 1950," Series P-44, No. 12, Bureau of the Census, June 12, 1944.

[3] Hagen, Everett E., and Kirkpatrick, Nora Boddy, "The National Output at Full Employment in 1950," *The American Economic Review*, September 1944.

[4] For the age and sex characteristics of this abnormal increase see "Sources of Wartime Labor Supply in the United States," *Monthly Labor Review*, August 1944, and Pearlman, Lester M., and Eskin, Leonard, "Teen-Age Youth in the Wartime Labor Force," *Monthly Labor Review*, January 1945, Bureau of Labor Statistics, U. S. Department of Labor.

million after war casualties, to arrive at a full employment labor force. An appendix to a forthcoming report of the National Planning Association adds 1.5 million, or a net of 1 million after casualties, and the authors express the opinion that it is probably not enough.[5] One cannot quarrel with these estimates but they set up a goal of "full" employment which will impress many people as unrealistic. It would be more conservative to assume that the permanent additions just about offset the war casualties.

Summarizing these calculations, the indicated increase in the labor force between 1940 and 1950 is somewhere around 6 million. A reasonable range for possible error is perhaps 1 million either side of that figure.

A projection for an intervening year would not be much less. If we accept the present consensus that war will continue in Europe until mid-1945, and that Japan will not be defeated until sometime in 1946, then 1947 will be a transition year. The large abnormal wartime increase in the labor force will not disappear automatically the moment war production is curtailed. It will take time for some war workers to use up their unemployment credits and decide to withdraw from the labor market. It will take time to demobilize those now in the armed forces who would like to return to school. Many of those who left school prematurely for war work will not return. They will be replaced gradually as the next generation remains in school.

Perhaps 1948 is the earliest year for which we should attempt to project a peacetime labor force. Because the rate of growth in adult population in the last half of the decade will reflect the lower birth rate beginning in the thirties, the difference between the 1948 labor force and that for 1950 will be less than 1 million.

The required increase in jobs is considerably greater than the growth in the labor force. The average number of unemployed in 1940 was 7.4 million.[6] That figure is subject to the usual qualifications because of the many difficulties encountered in defining and counting the unemployed. These difficulties, however, are relatively unimportant for our purpose. We can avoid them by merely assuming that the definitions and methods of enumeration are substantially the same now and will be the same in a postwar year as they were in 1940.

As usually understood the term "full employment" does not mean

[5] "National Budgets for Full Employment." The authors of the appendix are Loring Wood and Leonard Eskin.

[6] The Monthly Report on the Labor Force covers only the last 9 months of 1940. Estimates of the labor force, and therefore unemployment, were extrapolated for the first 3 months in line with the seasonal variations observed in later years. This calculation was taken from an unpublished memorandum by Leonard Eskin of the Bureau of Labor Statistics.

no unemployment. There is a substantial amount of "frictional" unemployment or "labor float" even during periods of high prosperity. It does not reflect any great distress or lack of employment opportunities. Even under the extreme pressure of wartime demands, unemployment has averaged 850,000 over the past twelve months.

The amount of this frictional unemployment which should be expected in a postwar year of full employment depends somewhat on one's concept of that goal. The forthcoming report of the National Planning Association, aiming at perfection, allows for only 1.5 million. Hagen and Kirkpatrick estimate 2 million as the practical minimum. Several people have used 3 million. The 4 million in the *Fortune* article on "Transition to Peace: Business in A.D. 194Q" is described as somewhat short of a full employment goal.

Perhaps somewhere between 2 and 3 million is the most reasonable figure. This leaves about 5 million of those unemployed in 1940 who should be employed if we are to have full employment. With the 6 million increase in the labor force this calls for roughly 11 million more jobs than in 1940. Thus the target is somewhere around 58 million jobs in 1950, including those in the armed forces.

	Labor force	Employed
	(in millions)	
1940	54.4	47.0
1941	55.7	50.7
		Full employment
1948	59–60	Circa 57.0
1950	60–61	Circa 58.0

This is an annual average. The seasonal variations from such an average, in both the size of the labor force and the number employed, may amount to several million in a particular month. Also the total number of jobs available at some time or other during the year, and the total number of individuals at work or seeking employment in the course of the year, will be substantially larger than any such average.

THE GROWTH IN OUTPUT PER WORKER

The growth in the labor force is more than matched by the long-term trend toward increased output per worker resulting from better tools, better management, new discoveries in the techniques of production and distribution, and shifts of manpower from occupations where productivity is low to industries where the output per worker is large. This secular trend can be clearly seen and measured in a number of segments of the economy where there are reasonably satisfactory data on employment and on physical output.

Over more than four decades from 1899 to 1941 the number of persons employed in all manufacturing increased by 130 per cent. During the same period the output of manufactures increased 458 per cent.[7] In spite of a 25 per cent decline in hours of work per week over that period the gain in output per worker averaged 3.1 per cent per year compounded.

Similarly, the volume of railway freight and passenger traffic per employee increased at an average rate of 2.5 per cent per year compounded between 1901 and 1941. The output of bituminous coal per employee increased at an average rate of 1.2 per cent per year from 1899 to 1941. The output per person engaged in agriculture increased 1.7 per cent per year from 1910 through 1941. Electric power output per employee increased 4.2 per cent per year between 1929 and 1941.

For the national output, as a whole, the trend is equally clear but it can be measured only with approximate accuracy. Any attempt to average the gains in particular industries encounters grave difficulties.

There are broad segments of the economy in which there is no satisfactory measure of changes in output per worker. For example, it would be difficult to reduce the output of a physician or an accountant to physical quantities. It can only be said in a general way that improved techniques and labor-saving devices have been introduced in many of these occupations, but that the gains probably have been less spectacular than in those industries where some measurement is possible.

A second difficulty lies in the fact that much of the over-all increase in output per worker comes not from improved efficiency within a particular industry but from shifts of employment between industries. When a man moves from a marginal farm to an automobile factory, for example, the dollar value of his output may increase from a few hundred dollars to several thousand dollars per year.

These difficulties can be partially avoided and a rough measure of the over-all increase in output per worker over the period from 1929 to 1941 can be obtained by comparing the total dollar output of goods and services with the total number employed.

In constant prices the 1941 gross national product, excluding work relief, was approximately 31 per cent greater than in 1929.[8] Total em-

[7] Sources and methods of calculation for the summary statements in this and the following paragraphs are indicated in the footnotes to the article on "Postwar Manpower and Its Capacity to Produce," *Survey of Current Business*, U. S. Department of Commerce, April 1943.

[8] The gross national product was broken down into 12 relatively homogeneous components and each component was deflated by the most relevant price series available. This is subject to all the usual doubts and difficulties of price deflation plus a few special ones. Therefore, the result is necessarily only a crude approximation.

The basic concept of an aggregate physical volume of goods and services which have no satisfactory

ployment, including the armed forces but excluding work relief, was 7 per cent greater. Thus the total national output per worker increased by roughly 22 per cent over the 12-year period or at the rate of 1.7 per cent per year compounded.[9]

	1929	1941	Increase (per cent)	Geometric mean increase per annum (per cent)
Gross national product, excluding work relief (in billions of 1941 dollars)	90.3	118.4	31	—
Total employment, excluding work relief (in millions of persons)	47.4	50.7	7	—
Output per employed person (in dollars)	1,905	2,335	22	1.7

The years 1929 and 1941 were used because changes in productivity are cyclical as well as secular. A recession causes a shift of workers away from the high productivity industries and a substantial amount of hidden unemployment in the form of part-time work, subsistence farming and the like. Thus any attempt to measure secular trends must compare two years at about the same point on the business cycle.

Comparisons covering a longer period would require the use of less reliable data for earlier years. However, the Hagen-Kirkpatrick calculations covering the period 1923 through 1941 produce practically the same answer.

Any projection of such a trend into the future implicitly assumes that in that hypothetical future year the composition of the national output and the amount of hidden unemployment will be roughly the same as in 1929 or 1941. This assumption appears reasonable with the one exception already included in the calculation. A postwar year of full employment excludes work relief by definition.

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common denominator is in itself a difficult although useful abstraction. Many individual items have been changed substantially over a period of years. For example, a machine tool produced in 1941 may weigh twice as much, cost three times as much, do four times as much work, and operate to much closer tolerances than the most nearly equivalent machine produced in 1929. If the same number of machines are produced, what is the change in physical output? Similar questions can be raised about almost every category of goods or services.

[9] It would be logical to treat the armed forces separately, in which case the increase in output per civilian worker would be 1.9 per cent per year. There is no reason to project the 1929–1941 trend of growth in the armed forces indefinitely. For any year near 1950, however, a separate calculation using the generally accepted assumption of two and one-half million in the armed services would not alter the estimates of total national output appreciably. My calculation is intentionally reduced to the simplest possible terms.

The projection of the prewar trend in output *per worker* also implicitly assumes a continuation of the secular decline in hours of work. This means that, by 1950, actual hours worked in manufacturing, for example, will average a little over 37 hours as against 40.5 in 1941 and 45.7 in 1929. The increase in *civilian* output per *man-hour* between 1929 and 1941 was considerably greater, averaging about 2.5 per cent per year compounded. Any projection of this rate, however, requires an explicit assumption as to hours of work.

The projection of the prewar increase in total output per worker is the simplest possible method. A much more elaborate analysis would involve separate calculations as to the trend of productivity in various segments of the economy, and explicit rather than implicit assumptions as to the composition of the postwar national product. It would not thereby avoid the basic difficulties of measurement and the final result probably would not be substantially different. The Hagen-Kirkpatrick estimates are the best example of this more elaborate method. Their projection of the output per employed person by 1950 differs from mine by less than 2 per cent.

It seems essential that the projection of the secular growth in productivity start with a prewar year and that it be applied to a year sufficiently beyond the end of the war so that wartime distortions can be ignored. For a number of reasons there is no satisfactory measurement of the changes in productivity which have occurred since 1941.

There is some evidence that in a number of nonwar industries postponement of new equipment purchases, high labor turnover and other abnormal wartime conditions have prevented the normal increase in output per man-hour. In other industries, such as aircraft and shipbuilding, the increase in productivity has been enormous. In the transportation, trade and service industries the apparent output per worker has been increased by reduction in quality of service which presumably will be restored when manpower and materials are again available. The increase in the work week and the concentration of workers in the high output industries are partially offset by the increase in the armed forces where the dollar value of the output per worker is low.

Changes in the composition of the gross national product since 1940 have been so enormous that any calculation of the net effect of these and other distortions is relatively meaningless. There is no satisfactory way of adjusting the wartime bill of goods for price changes in order to calculate the increase in physical volume of production since 1941. If the cost of a tank in mass production is compared with earlier experimental models the price has probably declined. This does not necessar-

ily mean that a million dollars worth of tanks in 1944 represents a greater physical output than a million dollars worth of haircuts before the war. If such an adjustment were possible it still would not indicate the changes which may have occurred in the Nation's capacity to produce a peacetime bill of goods under peacetime conditions.

These difficulties leave room for widely divergent conclusions. At one extreme there is the attitude that productivity has been increased greatly by the war and that the prewar trend will be resumed from this higher level. At the other extreme there is the opinion that there has been practically no increase since 1940 and that the prewar trend should be projected from the 1940 level beginning sometime after the war.

There is some justification for choosing, as a middle ground between these two extremes, the assumption that by 1950 the wartime distortions will have disappeared and the national output per worker will reflect a continuation of the prewar trend of about 1.7 per cent per year.

Some of the wartime abnormalities will not disappear automatically as war production is curtailed. They will be followed by other abnormalities during the postwar transition when many readjustments will have to be made and when speed in resumption of civilian production will be more important than efficiency. Therefore, any projection of prewar trends is valid only for a period well beyond the immediate postwar transition—probably not earlier than 1948 and possibly not until 1950.

There is little reason to believe, however, that the war has permanently altered the secular trend of productivity. Much of the spectacular increase in efficiency of war industries reflects the adaption of mass production methods already used by prewar civilian industries. Now techniques have been discovered and new skills acquired but their adaption to civilian production will be gradual. They are not likely to alter appreciably the normal average increase in efficiency for all types of economic activity. The secular trend will be determined less by spectacular recent developments than by wider application of tools and techniques which were already available but not fully utilized before the war.

While the available data are not sufficiently accurate for any precise calculation of changes in total national output per worker during and after the last war, the historical evidence tends to support this conclusion as to the continuity of the secular trend. In manufacturing, for example, there appears to have been no increase in productivity from 1917 to 1919 but a more rapid gain between 1919 and 1922 so that the latter year was just about on an extension of the prewar trend.

PRODUCTIVE CAPACITY OF THE POSTWAR LABOR FORCE

Using 1948 as the hypothetical postwar year, full employment would mean a little over 6 million or 12 per cent more jobs than in 1941. The output of these workers should be about 13 per cent greater so that a capacity national output would be 27 per cent above 1941. In 1950 the employment goal would be more than 7 million additional jobs and the capacity output 33 per cent above 1941.

Since we are not concerned with any particular year, and since the estimates are necessarily only rough approximations, the two calculations can be summarized by saying that sometime around 1948 or 1950 capacity of the labor force will be one-quarter to one-third larger than the actual production in 1941. It will be more than half again as large as the output in 1940 and 75 to 85 per cent above the 1935 to 1939 average. Projections well beyond 1950 should allow for further growth in both the labor force and its productivity.

This potential national output may be expressed in a number of ways: as gross product or net income, in 1939 prices, 1941 prices, current prices, or the price level you think will exist after the war. These variations can be quite useful for particular purposes. They can also be confusing to those who have no time to study the estimates closely.

The arguments as to which yardstick is the most accurate measure of this potential tend to obscure the basic and reasonably noncontroversial fact that the postwar full employment goal is a national output roughly half again as large as that actually produced in 1940. Because of the growth in the labor force, and in its capacity to produce, a return to the 1940 volume of business in 1950 would mean almost as much unemployment of that capacity as in 1932.

This estimate of the productive capacity of the postwar labor force is a target to shoot at. It is not a prediction of the volume of business which may actually be achieved after the war. It should not be referred to as a forecast.

The necessary expansion in the markets for all sorts of civilian goods in order to achieve a capacity national output staggers the imagination. We can comfort ourselves with the thought that the peak of every period of prosperity in the past probably approached this goal. But it is equally true that we have never succeeded in staying there indefinitely.

There is every reason to be concerned about the problems and possibilities of actually achieving full employment. There is much less reason to question the approximate magnitude of that goal.

THE DEMOGRAPHIC STATISTICS OF SOUTHERN AND EASTERN ASIA*

By Irene B. Taeuber

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Over a billion people live in a vast area stretching from India through Southeastern Asia and the Netherlands East Indies to China, Korea, and Manchoukuo. The major common element in all the diverse cultures of this region is the dependence of the majority of the people on a fundamentally subsistence agriculture which, under the existing technological conditions, permits only sub-standard levels of living. The application of modern science and technology to agriculture might result in increases in acreage and yields sufficient to provide minimum levels of living for populations of the size of those now inhabiting the area, but the widespread educational activities necessary to implement a comprehensive agricultural program would result in the diffusion of knowledge of the basic principles of health and sanitation. This knowledge, taken in conjunction with the increased and more stable food supplies implicit in the widespread application of modern science to agricultural production, would result in rapid declines in mortality and hence accelerated rates of population increase. If agricultural improvements are to result in increasing levels of living, the rate of increase in physical productivity must be greater than that of population. Realization of the dilemma created by the interrelationships of agricultural improvements and population increase has been one of the major factors leading to an increasing emphasis on industrial development as an essential element in any plans for permanent alleviation of the mass poverty of Asia.

THE DEMOGRAPHY OF INDUSTRIALIZATION

The major demographic advantage of industrialization in the Western cultural area was that it introduced a widely ramified process of change that led ultimately from the relative population stability at

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This brief and partial statement of the demography of Southern and Eastern Asia is based almost entirely on analysis of the official census and vital statistics publications of the individual countries, together with a utilization of the demographic studies made in Asia itself as a basis for interpretation. Citations to detailed sources are too voluminous to include here. A fairly comprehensive coverage of the official and non-official statistical publications of the recent period and brief resumes of the demographic situation in various areas within the Southern and Eastern Asiatic region have been presented in the issues of *Population Index*, Vols. I to X.

The conclusions drawn are the responsibility of the author and are not to be interpreted as official views of the Bureau of the Census.

high levels of mortality and fertility which characterized the early medieval period to the slowing growth or actual decline at low levels of mortality and fertility which characterized the interwar period. The initial effect of both the agricultural and industrial revolutions was to decrease mortality, leaving relatively intact the large family pattern which had been essential to group survival in the subsistence agrarian economies of the pre-modern world. Gradually new individual and group values developed in response to the changed conditions of working and living in industralized urban areas. As the small family pattern became not alone an ideal but a goal realized by increasing proportions of the population, birth rates fell rapidly, at first in cities, later in the surrounding rural areas. Projection of the trends to declining mortality and fertility into the future indicates that Europe as a whole would have achieved population stability within a generation, even without the losses of the present war.

The population growth which will probably accompany the postwar industrialization of the billion people of Southern and Eastern Asia, if and when it occurs, is not predictable on the basis of European experience. Available evidence from Soviet Asia, Japan, and parts of the Near East indicates that the declining mortality and fertility which constitute the basic correlates of industrialization and urbanization in Asia may be similar in broad outline to those which occurred earlier in Europe, but with differences in both the magnitude and the timing of the processes of change. Broad comparability of the pattern of change in the past does not justify the utilization of the past experience of one area to predict the future of the other, since the divergent factors are numerous. The Southern and Eastern Asia of the prewar period contained about twice the entire population of the world in the middle of the seventeenth century. An agrarian Asia which is already densely settled according to any system of agricultural technology which now appears feasible is subject to the impact of a mature technology. No Western Hemisphere remains to serve as an economic and demographic safety valve for an expanding Asia.

The measurement of the population potential of Southern and Eastern Asia through the mathematical projection of past rates of growth within the region itself into the future is logically indefensible if the goal of the projections is the derivation of rates of increase which will aid in planning for or administration of operating programs. Growth curves fitted to the populations of India, Java, Manchoukuo and parts of China have served the generally useful purpose of indicating the greatly increased populations inherent in the future if the trends of the

past continue. However, the projection into the future of empirical growth curves fitted to the generally questionable population estimates or counts of the past gives a fictitious appearance of inevitability to the demographic trends of Asia. Mechanical projections cannot alter the fundamental fact that even the present balance of people and food supply in Southern and Eastern Asia is quite precarious, and that future population growth is basically dependent on future economic and political developments. The relationship between the number of people and the food available for their support is a very direct one in such densely populated areas as Java or the great river valleys of India and China.

DEMOGRAPHIC CHANGE IN SOUTHERN AND EASTERN ASIA

The logical approach to the probable demographic trends of a politically stable and industrializing Asia is a series of detailed analyses of the dynamics of population in those regions of Asia where adequate statistics permit relatively controlled analysis. It seems reasonable to assume that the effects of comprehensive and planned industrialization will represent a continuing intensification of the impact of the economy of the West to which many of the peoples of Southern and Eastern Asia have been exposed during the centuries of European expansion.

It should be stressed in advance that analysis of the statistics for those selected regions which have statistics of even minimum accuracy permits few generalizations concerning the growth of Southern and Eastern Asia as a whole, since there is a definite correlation between political stability, economic level, non-native rule, and the development of statistical systems.

Rapid growth has been the major demographic characteristic of all regions of Southern and Eastern Asia, with the possible exception of China, where definitive information on trends in total population is lacking. Intercensal rates of increase may be taken as approximate measures of the actual rates of increase, although the successive censuses in any area tend to become more inclusive. India's increase of 1.4 per cent per year in the decade between 1931 and 1941 was less than that in most other regions of Southern and Eastern Asia outside China Proper. Average annual rates of increase during the last intercensal period were 2.2 for the Philippine Islands, 2.4 for Formosa, and 3.0 for Thailand.

The vital statistics of Asiatic countries are generally deficient in both coverage and accuracy, but there is conclusive evidence that the increasing rates of natural increase in the recent period have been due

to the coexistence of declining mortality and relatively stationary fertility. Factors responsible for the decline in mortality include the extension of areas of political stability, the improvement of agricultural production, the introduction of minimum sanitary regulations, epidemic control measures, and the provision of famine and disaster relief. The growth pattern produced by a precarious control of mortality is portrayed graphically in that extraordinary series of population censuses which have been carried out in India. The relatively prosperous decade of 1881 to 1891 produced a recorded increase of 10.9 per cent, but the great famines of 1899 and 1900 reduced the increase of the decade 1891 to 1901 to only 1.5 per cent. Population increased 6.5 per cent in the decade 1901 to 1911, but the death of some 13 million people from the influenza pandemic and the generally higher mortality of the war and immediate postwar period resulted in a negligible increase of 1.2 per cent between 1911 and 1921. The rate of increase went up to 10.6 per cent between 1921 and 1931. If the previous cyclical pattern had continued, there would have been widespread famine or plague by 1941. Instead, the census of 1941 indicated a population of 388.8 millions, an increase of 50.7 millions or 15 per cent in the decade 1931 to 1941.

JAVA AND THE PHILIPPINES

The details of the demographic change in process in Southern and Eastern Asia can be seen more clearly in some of the smaller areas rather than in the vast and complicated social and political structure of the Indian subcontinent. The island of Java constitutes one of the best of the laboratory situations. Civil disorder, ignorance of the basic principles of sanitation and nutrition, a fluctuating food supply, and epidemic and endemic diseases retarded population growth until the eighteenth century. Then the colonial administration of the Dutch began to penetrate every phase of the life of the people, maintaining peace and order, introducing public health measures, spreading elementary notions of hygiene, and improving agricultural techniques. The admittedly inadequate estimates indicate that the native population of Java and Madura alone increased from about 5 millions in 1816 to 13 millions in 1861, 30 millions in 1905, 41 millions in 1930, and an estimated 48 millions in 1940. Continuing increase at the rate of 1.5 per cent per year, a rate less than that which has been occurring in the recent past, would produce a population of 116 millions by the year 2000—an obviously improbable figure if the future were to remain one of essentially primitive though somewhat rationalized subsistence agriculture.

The wider relevance of Javanese experience for economic and political planning for the Asia of the postwar period is indicated by contrasting the demographic history of Java with that of the nations of Western culture. In Europe, the decline in mortality accompanied a widespread process of industrialization and urbanization which had as a secondary consequence a modification of the traditional large family pattern. The growth cycle initiated by declining mortality was braked and ultimately almost terminated by declining fertility. In Java, on the other hand, the decline in mortality was accompanied by few fundamental changes in the social structure and mode of existence of the native peoples. Natives reached by elementary education attended vernacular schools taught by natives. Native systems of land holding, community organization, and local administration remained relatively unchanged. Since the ways of life, the attitudes and the values which determine family mores remained intact, the birth rate remained essentially at its primitive level. Ideal as Javanese colonial administration may have been from the standpoint of the preservation of the functional unity of native life, it created a demographic dilemma which seems likely to lead ultimately either to a decline in fertility or to the restoration of higher levels of mortality. Migration to the Outer Islands can serve only as a temporary palliative.

Java alone cannot be assumed to represent the process of demographic transition that has been occurring in other Asiatic areas subject to the impact of Western culture, since it may be argued that the enlightened and efficient colonial policy of the Dutch produced an atypical situation. Analysis of the series of Spanish and American censuses of the Philippine Islands for the period from 1879 to 1939 reveals a process of demographic change essentially similar to that occuring in Java. Some evidence of differential fertility is found in the data of the census of 1939, since ratios of children to women were lower in the more prosperous areas, and in those in more direct contact with the outside world. This may represent the beginning of a progressive decline in fertility, but the general pattern of fertility throughout the Philippines as a whole remained that of a people reproducing at or near maximum levels. The average number of children ever born was 4.7 for all women, 6.2 for women 35 to 44, and 6.5 for women 45 to 54. Seventy-five per cent of all married, widowed or divorced women aged 45 and over had borne more than three children; 24 per cent had borne four to six; 27 per cent seven to nine, and 23 per cent, ten or more. Thus the evidence of the coexistence of declining mortality and stable or slowly declining fertility in the Philippines is indisputable, but

transfer of the evidence from the Philippines to other Asiatic areas would lead to results even more suspect than in the case of Java, since American policy in the Philippines was based on the concept of trusteeship, the goal being the development of an economy, a social level, and a political consciousness that would permit independence.

FORMOSA AND KOREA

That the initial impact of Western economic and sanitary technology on population growth is relatively independent of humanitarianism, enlightened paternalism, and other aspects of the ideological base of Western culture is indicated by the occurrence of demographic transitions similar to those in India, Java, and the Philippine Islands in the various parts of the prewar Japanese Empire. In Formosa, the Japanese conquerers maintained the native Chinese peoples in relative isolation from the outside world, with minimum possibilities for individual or group cultural and economic development. The Japanese demographic goal for Formosa was an abundant and cheap labor supply for use in a commercial agriculture that was to assist in eliminating the dependence of Japan on foreign sources and to contribute to its foreign exchange. Rational progress toward this goal necessitated the development of public sanitation, compulsory vaccination, malaria control, and other public health measures. The demographic consequences of an increasing and more stable food supply, the elimination of epidemic diseases, the control of endemic diseases, and the diffusion of elementary sanitary knowledge were similar to those in India, Java, and the Philippines—a decline in mortality without appreciable declines in fertility. Recorded death rates decreased quite consistently from 32.9 per 1,000 total population in 1906–1909 to 19.9 in 1935–1937; birth rates, on the contrary, remained relatively constant, ranging from 40 to 44 per 1,000 total population. The result of the coincidence of declining mortality and stable fertility was an extraordinary rise in the rate of natural increase, which reached 24.4 per 1,000 total population per year in the period 1935–1937. Gross reproduction rates were over 3.0 in 1929–1931 and 1934–1936. Net reproduction rates computed on the basis of the mortality of the 1926–1930 life tables for Islanders were over 2.0 in both 1929–1931 and 1934–1936.

The demographic transition has been essentially similar in the other regions dominated by pre-Pearl Harbor Japan, including Manchoukuo. Available census and vital statistics data for Korea permit a more detailed analysis of the process of change than is possible for either Formosa or Manchoukuo. In Korea, the decline in mortality which

has been the dominating variable in the increasing rate of natural increase is due primarily to the decline in childhood mortality and to the control and virtual elimination of the catastrophic deaths associated with famines, plagues, and natural calamities. This experience would suggest that the maintenance of rudimentary sanitary controls in an economy which provides a fairly stable subsistence diet undercuts mortality sufficiently to produce rapid natural increase if the social system remains one in which marriage is universal and marital fertility uncontrolled. If this theory is valid, rapid population growth may be a necessary correlate of the achievement of the effective political occupation and the efficient economic utilization of an area. The political and humanitarian philosophies underlying the determination of economic policies may be instrumental primarily in determining the rapidity of the decline and perhaps its detailed pattern by age, sex, and cause of death.

Korean statistics offer clues as to the probable process of change in fertility patterns in the future, but generalizations from this experience must be made with caution. Crude birth rates estimated from census age distributions reveal only insignificant fluctuations around a rate of 45 per 1,000 total population in the ten year period covered by the censuses of 1925, 1930 and 1935. Gross reproduction rates for the same period are over 3.2. Since fertility was relatively stable and mortality was declining, the net reproduction rate increased from 1.7 in 1925 to 1.8 in 1935. In 1930, gross reproduction rates revealed variations within a general pattern of high fertility, the lowest gross rates being found in the relatively more urban prefectures. Even more, in all Korea, in each of the thirteen provinces, and for both Japanese and Koreans, fertility ratios were higher in the rural areas than in the cities, and in every province and in every city the fertility ratios of Koreans were higher than those of Japanese. The mechanism responsible for the lower fertility of urban Koreans was the postponement of marriage. Data are not available for an analysis of the detailed process of change between 1930 and 1940, a period characterized by relatively rapid urbanization and industrialization as the natural resources and the people of Korea were utilized to compensate for the industrial deficiencies and the strategic vulnerability of Japan Proper.

THE PATTERN OF DEMOGRAPHIC TRANSITION

Even partial analysis of the admittedly inadequate statistics available for various local areas within Southern and Eastern Asia indicates the general nature of the demographic transition which has been in

process since the initial contacts with the diffusing industrial economy of the West. The first consequence of the expansion of areas of civil order, an increased and stable food supply, epidemic controls, and rudimentary sanitation, is the virtual elimination of the decimation of populations through famine or epidemics, and a decline in the general death rate, particularly that of infants and young children. This situation of declining mortality and stable fertility at a level adequate to maintain populations in their prior conditions of higher mortality can be only temporary. Regardless of the potentialities for increasing the resources for the support of population, sooner or later growth must cease, either through a decline of fertility or through a restoration of the earlier levels of mortality.

There are some indications within the experience of Java, the Philippine Islands, and Korea that increasing levels of living and advancing educational and cultural opportunities within an urban culture are accompanied by declining fertility in the East, just as they were earlier in the West. In Japan, the trends in fertility throughout the modern period of industrialization and urbanization have been roughly similar to those of the West, although differences in the underlying culture and variations in the type and speed of industrialization have produced differences in detail. The decline in fertility during the recent period has been primarily a by-product of urbanization. The major part of the decline in the intrinsic birth rate from 34.1 in 1930 to 31.7 in 1937 was due to the increasing proportion of the total population living in cities rather than to changes in rural or urban fertility per se. The decrease which did occur in the fertility of the rural and small-city population was correlated directly with an increase in the average age at marriage and a decrease in the percentage married at the younger ages. However, there is fairly conclusive evidence of the control of fertility within marriage in the cities of 100,000 and over.

The demographic history of Southern and Eastern Asia itself indicates that the future development and expansion of industrializing economies in the postwar period will lead to rapid acceleration in rates of population increase unless the population pressure under existing conditions is so acute or the disorders accompanying the economic and political transitions are so great that the declines in mortality cannot occur. It is a logical deduction from the demographic history of Western nations and Japan, and to some extent the experience of mainland Asia itself, that urbanization, increasing levels of living, and general educational and cultural advancement will lead to declines in fertility and the ultimate cessation of population growth. Whether or not this hypothetical transition actually occurs depends on the economic and political history of Asia of the future, not on demographic factors alone.

STATISTICAL IMPLICATIONS

If the present and probable future demographic trends within Southern and Eastern Asia are those outlined here, one of the fundamental statistical needs in Asia during the postwar period will be the quantitative expansion and qualitative improvement of census and vital statistics systems. Periodic inventories of human resources and current information on rates of natural increase and the internal redistribution of the population are essential to both national and local planning and operation in the economic and health fields. Minimum preparation for cooperation with the statisticians of Asia in planning the development of new statistical organizations or the modifications of old organizations to meet the greatly increased statistical needs of the future would seem to necessitate a careful analysis of the organization, administration, technical procedures, and results of the censuses and vital statistics systems which now exist in the various regions of Southern and Eastern Asia.

The careful analysis of existing demographic data is only in its initial stages, especially for Southeastern and Eastern Asia. The statistical data which exist for local areas or regions of China are practically unknown to Western demographers. As the statistical blackout in the Japanese Empire is lifted, vital statistics for the prewar and war periods, the detailed data of the Empire censuses of 1940, and the results of special war surveys and registrations in both the Empire and the Occupied areas of Asia will become available for analysis. The influence of the industrialization, urbanization and internal migration of the war period on the dynamics of population in Eastern Asia remains to be determined. The Manchoukuo Census of 1940, taken in conjunction with the returns of the registration system and the data on labor migration, will permit analysis of the economic and demographic aspects of one of the great migratory movements in modern history. Projects involving the coordinated analysis of the resources, the social and political organization, the economic possibilities, and the demographic factors in specific regions of Asia under various assumptions as to feasible alternative developments would be even more significant than demographic analyses undertaken in isolation.

This inventory of needed research on the demography of Southern and Eastern Asia could be continued indefinitely. The projects noted here may serve as partial documentation of the fact that further demographic analysis of the statistical records of the past and careful planning for the development of more comprehensive statistics in the future should be given high priority among the postwar responsibilities of American demographers.

THE MASTER SAMPLE OF AGRICULTURE *

I. DEVELOPMENT AND USE

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THE DEMAND for accurate and timely information during the war has hastened the development of a new and efficient method of sampling. This method, which has become known as "area sampling," is adaptable to many kinds of surveys where the sampling units are visited personally. At the Statistical Laboratory, Iowa State College, a Master Sample that will facilitate the designing and use of future area samples has been developed by the Bureau of Agricultural Economics and the Bureau of the Census. In developing the Master Sample, materials which are difficult to obtain have been collected and assembled, and much of the time-consuming clerical work required in designing area samples has been done; thus with the Master Sample it is now possible to design other area samples quickly and efficiently. The size of the Master Sample makes it possible to plan surveys so that no particular group of farms will be overburdened with interviews from different government agencies. Furthermore, the accumulated information obtained from the surveys taken will provide a clearing house of information for the various agencies using the sample. Such information in some cases will make it unnecessary to ask the farmers more than once for the same facts. The information will also be used to reduce the sampling errors of subsequent surveys.

Methods of sampling used in the past.—Among the most popular methods of extensive sampling used in the past, three are of special interest for comparison with area sampling; these are the mailed inquiry, the random point, and the quota method. All three have two basic weaknesses. In the first place, when applied, they usually give biased samples of the population under study. Secondly, they usually depend upon historical information as a basis for expansion. For example, many farm sample inquiries are designed merely to obtain an estimate of some average, such as a mean of an item per farm, which for an estimate of a total, is multiplied by a guessed, an assumed or an estimated total number of farms. These guesses, assumptions, or estimates are usually

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based on the last-published census figure. The census data are from one to two years old at time of publication and seven years may pass before new information becomes available. If the number of farms has changed in the meantime, any estimate based on this quantity is in error. Furthermore, if the census number of farms is used as a basis for expansion, it is essential that the definition of the farms in the sample be consistent with that used in the Census. Otherwise an additional bias may occur. This restricts the usefulness of the three methods because the farm definition used in the Census is not satisfactory for all kinds of inquiries.

The mailed inquiry is generally accomplished by sending schedules to a predetermined list of persons or by having them distributed by mail carriers as they travel their routes. This method of sampling has been popular among federal agencies because it is easy to administer and does not require a field force of enumerators. A large number of returns can be obtained at a low cost. In spite of its susceptibility to serious bias the method has been widely used where a large number of reports are required to estimate agricultural inventories which vary greatly from farm to farm, and also where geographic detail is needed. In these cases the smaller sampling error due to the large number of reports offsets somewhat the effect of the biases which are not taken care of in the estimation procedure.

Mailed inquiries have very definite limitations. The short questions that must be used are not feasible in many surveys which require indirect questioning, such as attitudinal surveys, or where questions are technically difficult, as in many farm-management inquiries. Results from mailed inquiries are usually biased because it is difficult to obtain returns from those who are indifferent or who have writing or language difficulties.

The quota method of sampling is familiar to almost everyone because of the great amount of publicity that it has received by its use in election forecasts, public opinion polls and marketing surveys. In this method the population is divided into a number of strata or cells, and the sample is drawn proportionately from each cell. The number of sampling units required in each cell is called the quota for the cell. Ordinarily the method is relatively simple to prepare, but it has some weaknesses which may be serious for many inquiries. The quotas which are set up to be filled by the enumerators are usually based upon census and other information. Since the census information is historical, the quotas may not be in agreement with actual population proportions at the time of inquiry. In periods of rapid change, such as in depressions

and wartime, these quotas may result in biased samples. Then too, the selection of the individual within a quota group is left to the discretion of enumerators and this may lead to biased selections of individuals. Furthermore, this method is limited because it depends upon the Census as a basis for expansion.

The random-point method of sampling became popular for a few years but it is now probably losing favor for locating farms. In this method, points are located at random on maps and a certain number of farms nearest the points are included in the sample. A sample using this method can be quickly designed. Furthermore, the cost per schedule can be reduced by enumerating more than one farm at each point in order to reduce travel among farms. The returns are biased, however, because the random points are more likely to fall upon the large farms than on the small ones. Therefore, more complicated estimation procedures must be adopted and some outside information must be available both for removing bias and as a factor in estimating totals.

It is realized that in a particular inquiry a biased method of sampling may still give more accurate information per dollar spent, provided that a substantial number of returns can be obtained cheaply. However, since the Master Sample was designed to provide the basis for a large number of surveys on many different topics, it was considered desirable that the sample should be free from bias.

In the area sampling with which we are concerned the sampling units are small areas and every unit of observation is uniquely associated with one and only one such area. Furthermore, the total number of such area sampling units in the population is presumably known so that the proportion sampled (i.e. the sampling rate) is known. To obtain an unbiased selection of farms we may select those whose headquarters are located within the boundaries of the sample area regardless of where the boundaries of the farm may extend [7]. Similarly, an unbiased selection of persons can be obtained by taking all who reside within the sample area. As a further example, an unbiased selection of land area may be obtained by selecting for measurement all land confined within the boundaries of the sample areas [9], [10]. Finally, an unbiased selection of fields may be obtained by taking those fields which have their northwest corners within the boundaries of the sample area.

Area sampling may be extended to provide the primary selection of units of observations which are then subsampled. The subsampling is usually accomplished either by a further sampling of smaller areas or by making a prelist of individuals; from this a small and possibly stratified sample may be drawn for a more lengthy interview. This method of

sampling is commonly used by the Bureau of the Census and some others in sampling cities, counties, or other areas where the blocks are the areas which are prelisted and subsampled. The subsampling scheme is also contemplated for the Master Sample for its basic data can provide the necessary prelist information without the field work usually required.

Use of areas in sampling was widespread in Europe during the 1920's and early 1930's by Bulgaria [1], Italy [3], Poland [11], Sweden [5], etc. In all these samplings the areas were relatively large and often purposively selected. Jerzy Neyman [11] in his paper published in 1934 recommended: (i) that in general the stratified random selection of sampling units is preferable to purposive selection and (ii) that the sampling units should be small and widely scattered for maximum sampling efficiency. In the later 1930's some experimentation with area sampling of farms was undertaken by members of the Bureau of Agricultural Economics and the Bureau of the Census. In the Bureau of Agricultural Economics an investigation initiated by Sarle [6] in 1936 was designed in part to study the sampling efficiency of the survey section as an areal unit compared with that unit comprising single farms and strings of from two to ten farms. J. B. Shepard in 1937 suggested that an agricultural sample census be taken [12] using the township as the sampling unit. Another investigation, initiated by Sarle [13], was directed to study the efficiency of the township as a sampling unit. Hansen has indicated that the Bureau of the Census also used the area method of sampling in 1936–37.

In most of these sampling investigations, it was generally hoped that the large area, such as the township, would win out over the smaller unit but nearly always the latter was found to be the more efficient. In 1937, a new use of area sampling was introduced for sampling crop acreages. This scheme, which appears to have originated independently in India [10] and in this country [9], requires the measurement of crop acreages contained within the sample areas, which in both of these samplings were relatively small. The study in this country was made possible by the extensive use of aerial photographs.The areas of fields in crops or parts of fields lying within the boundaries of the area units were measured on aerial photographs. In 1938 and 1939, Iowa State College cooperating with the Bureau of Agricultural Economics made two statewide farm surveys [7] in which the quarter-section was used as the sampling unit. Each farm with its farmstead falling within the unit was enumerated. Later, in 1940 and 1941, statewide surveys [8] were made in Iowa and Arkansas by a large field force of WPA workers,

using the survey section as sampling unit. In 1942, the Bureau of Agricultural Economics made surveys in California, Florida and New Jersey to obtain farm labor information [8]. The Bureau of the Census in 1942 used the area method plus a subsampling scheme [2] in their new sample for estimating the United States labor force. About the same time, members of the Bureau of the Census [4] extended and further developed the theory for subsampling. Along with studies on the statistical efficiencies of areal units of different sizes, it has been found by Mahalanobis [10] and Jessen [7] that consideration should be given to cost because it too is a function of size.

Advantages and disadvantages of the area method.—It has been shown by Jessen and others that the area method gives an unbiased sample for agriculture. It has the further advantage that the units of observation are clustered in such a way that the sampling error can be minimized on the basis of cost. The reduction in cost is accomplished by reducing the travel between farms. The method is also adaptable to such modern techniques as stratification, double sampling and subsampling for reducing the sampling errors. An expansion factor available to the area method is known without error because the total number of sampling areas in the population may be determined by simply counting them on the maps. Hence, it is not necessary to bring in outside information which may be inaccurate (e.g., census data which may be out of date) in order to make total estimates. For agriculture it has the further advantage of giving an estimate of the number of farms which is seldom known with satisfactory accuracy. If repeated samples are taken, the correlation that usually exists on sample areas from year to year can be utilized in the area method to reduce the sampling error by appropriate sample designs and estimation procedure. The gains available by such a technique have been shown by Jessen [7] to be of considerable value. Designs of this sort are not free of bias if the sample units consist of farms, because farms are not permanent through time as are areas, and farms coming into or going out of existence may differ greatly from those of more permanent character.

The area method has certain disadvantages which are more operational than theoretical. It requires maps of detail sufficient to allow the delineation of the sample areas which may be located easily and accurately by the enumerator in the field. At the present time such maps are not always available. It is, therefore, advisable in some parts of the country to supplement the best available maps with aerial photographs, especially when the smaller, more efficient unit is used in the nonsurveyed regions of the country. These requirements lead to several

specific difficulties. In the first place, there is no single source from which the best available maps may be obtained. This causes great expenditure of time and money to bring them together. In the second place, although a large part of the United States has been photographed by the Agricultural Adjustment Agency and other agencies, there is the additional cost and time required to obtain reproductions of the photographs.

Another disadvantage of the area method is that, given maps of sufficient detail, it takes time and money to delineate on maps areas that are efficient in size and that are bounded by features which can be clearly identified in the field. Consequently, a sample using the area method cannot be designed quickly and at the same time efficiently. These operational difficulties have in part led to the development of the Master Sample. The Master Sample at the present stage of its development is made up of 67,000 areas which identify about 300,000 farms (the areas for the United States averaging about five farms) located within nearly every county in the United States.

History of the Master Sample.—Early in 1943, the idea of a Master Sample occurred to Rensis Likert of the Bureau of Agricultural Economics. The BAE at that time was working on a group of bureau-wide projects. It was evident that there was need for a procedure which would provide effective samples for various studies and more particularly which would enable the accumulation of data relating to a representative group of farms. By drawing subsamples for different studies from a large Master Sample and systematically accumulating the data from these farms and farm families, many important interrelationships affecting farm production, income and living which cannot now be studied economically could be analyzed. Thus a Master Sample could become a device for integrating and improving the effectiveness of the research of the Bureau. Likert sought the advice and help of the writer in preparing a proposal for developing a Master Sample. Because of its demonstrated advantages the area method of sampling was recommended.

It was first decided in April 1943 that the Statistical Laboratory at Iowa State College would design a set of areas which would provide a national sample of about 5,000 farms. At this point the name "Master Sample" was applied and is still being used although the scope of the sample has been enlarged materially. The work was assigned to Iowa because the group there was experienced in such sampling as a result of the research work on sampling that has been carried on for several years cooperatively by Iowa State College and the Bureau of Agricultural

Economics. As the greatly increased demand for this type of sample became apparent, the planned size was increased at first to 25,000 farms and later to 300,000 farms, as the Division of Agricultural Statistics became interested in the proposed Master Sample as a basis for taking large surveys of farm inventories.

At this time plans were being drawn in the Bureau of the Census for the 1945 Agricultural Census. The Bureau of Agricultural Economics was interested in having the Bureau of the Census identify the schedules of the farms in the Master Sample so the census information could be used for subsequent sampling purposes. The Bureau of the Census became interested in using the Master Sample in connection with the 1945 Agricultural Census because it would provide a suitable group of farms from which information for a supplementary schedule could be conveniently obtained. The identification of the Master Sample farms would make it possible to separate these schedules for making estimates prior to the total tabulations. Furthermore, the maps and the costly materials for reproducing the maps necessary for the Master Sample as well as the aerial photographs could be used in the Agricultural Census. When it became evident that the Bureau of the Census could also derive benefit from the Master Sample, an agreement was drawn up whereby the Bureau of Agricultural Economics and the Bureau of the Census could combine their technical and administrative resources to develop the most efficient sample feasible. Under this agreement the Master Sample was completed in time to be used in the Agricultural Census as planned.

However, one more development has arisen which further enlarges the scope of the Master Sample. Shortly before its completion, the Bureau of the Census wanted to extend the sample so that it would represent the entire population. The areas set up for agriculture were not efficient for population samples in the cities and villages where the size of the sampling areas was determined by the number of farms rather than the number of persons. In the village and town stratum the Master Sample is being redrawn with smaller areas; in the open-country stratum, however, the present sample is satisfactory for either farms or population inquiries. This work is going forward at Iowa State College where the agricultural sample was drawn. The Bureau of the Census is at present drawing what may be called a "Master Sample of City Areas" to serve in city areas as the Master Sample does in the rural areas. The two projects are being designed as integrated parts of an over-all plan. Work on the extension of the Master Sample and the city sample is just getting started and the entire job will probably not be

completed for another year. Priorities, however, are being given to a sample of counties that can be used shortly.

When the Master Sample is finally completed in its extended form, it will be available for the proposed 1946 sample census of population. In an attempt to strengthen its statistical program the Bureau of Agricultural Economics plans to use the Master Sample for its more difficult and important inquiries. Requests from state agencies to use the Master Sample within the states have been received.

Steps are being taken to put the administration of the Master Sample on a sound basis. The maps, photographs and other materials will be put under centralized control. A joint committee has been set up by the Bureau of Agricultural Economics and the Bureau of the Census to lay broader policies for administering the Master Sample. A traffic problem has already developed and the committee is now working on its solution. The Bureau of the Census and the Bureau of Agricultural Economics are being staffed to advise and help in the designing of samples that use the Master Sample. Plans are being drawn jointly by the two agencies and Iowa State College for extensive research to determine the sampling errors of the Master Sample with different methods of estimation when used as a whole or when subsampled. Facilities will be provided to redraw the sample in the counties where the sample has been overworked.

In summary it may be said that the area method of sampling is an improvement over other designs because (i) it does not depend upon advance knowledge of the characteristics of the population, (ii) it eliminates freedom of choice on the part of enumerators, and (iii) it is usually efficient from the standpoint of maximizing precision on the basis of cost. Although the designing of area samples is time-consuming and the initial cost high, usually it has been found to be justified. The Master Sample of agriculture will greatly facilitate area sampling by providing maps and other materials, tabulations, and other information helpful in the efficient design of area samples. It has been indicated that the Master Sample will be widely used in many different kinds of surveys for national as well as state inquiries.

II. DESIGN

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As the idea of the Master Sample developed, its scope and objectives suggested a sample with the following specifications:

(i) That it be large enough to provide an adequate group of farms on which information can be obtained that will be useful for selecting efficient smaller samples for special inquiries and coordinated studies.

(ii) That it be general or flexible enough in basic design so that it may be used directly, or with simple modification, for sampling not only farms but rural population, land use, crop diseases, crop pests, etc.

(iii) That it be distributed geographically to such an extent that all of the primary sampling units, of the kind now commonly used, comprising single counties or groups of counties, will likely have an adequate sample of areas within each convenient for subsampling.

(iv) That it be specific enough as to the population sampled so that it may be conveniently and precisely extended to inquiries which deal mainly with elements other than farms.

(v) That it be efficient enough so that it may justify its cost.

(vi) That it be practical enough so that estimates from it can be made without unnecessarily complicated procedures and that the field work can be simply and accurately carried out.

(vii) That it be completed in time so that it may be used as an integral part of the 1945 agricultural census.

The plan or design of a sample proposed to meet these specifications was developed during the last half of 1943, when the above general specifications and others were taking final form and when many of the more technical features were still being tested. The purpose of the present paper is to present as simply as possible a description of the design of the Master Sample.

General.—The Master Sample is a sample of small areas which average about 2.5 square miles in size but which vary according to location and other circumstances. Nevada has the largest average size: 108 square miles; Indiana the smallest: 0.71 square miles. The sample areas have been selected from every one of the 3,070 counties[1] of the United States and contain within their boundaries approximately 1/18 of the land area of the United States, 1/18 of the farms (about 300,000), 1/18 of the rural population, etc.

By design, these small areas were formed to contain, within reasona-

[1] Actually some counties contained such few sampling units that occasionally a county would fail to have a selected area.

ble limits, a given desired number of farms or persons within reasonably identifiable boundaries. A big procedural job was the setting up of criteria for use in determining the size, shape, boundaries, etc., of these areas.

The primary strata.—Three primary strata were defined on the basis of incorporation and density of population. The total area of the United States was classified into: (i) incorporated areas, (ii) unincorporated areas relatively densely populated, (iii) unincorporated areas relatively sparsely populated. For convenience those area groups will be called the (i) incorporated, (ii) unincorporated, and (iii) open country strata.

The incorporated stratum, as the name implies, includes all incorporated cities and towns. In addition, unincorporated places regarded as "urban" by the Bureau of the Census were also included. Partly for desired flexibility of grouping and partly for sampling efficiency, all places in this stratum were further stratified into "rural" and "urban" groups according to Census rule, that is, those places having a population in 1940 of less than 2,500 persons are classed "rural" while those of 2,500 or more population are classed "urban."

The unincorporated stratum consists of all name places, outside of incorporated areas, which have an estimated population of 100 or more, and all other areas which appear on the map to have a population density of 100 or more persons per square mile. Estimates of population for these places were obtained from the *Rand McNally Commercial Atlas*, Bureau of the Census report on unincorporated places and the county highway maps. Places within the stratum were further stratified into the three size groups: (i) population 100–499, (ii) population 500–999, and (iii) population 1,000 and over.

The area remaining after the designation of the incorporated and unincorporated areas may be labeled "open country." This "open country" stratum contains 96 per cent of the land area (see table) and about 91 per cent of the farms of census definition. In this stratum an attempt was made to obtain a design satisfactory for sampling either or both farms and persons, whether farm or non-farm.

PERCENTAGE OF LAND AREA, SAMPLE AREAS, 1940 CENSUS FARMS, 1940 TOTAL POPULATION IN EACH OF THE THREE PRIMARY STRATA

Stratum	Land area (Per cent)	Sample areas (Per cent)	Census farms (Per cent)	1940 Population (Per cent)
Incorporated	1	3.4	3.4	63.6
Unincorporated	3	6.4	5.9	10.5
Open country	96	90.2	90.7	25.9
Total	100	100.0	100.0	100.0

With the strata so defined the next step was to designate them properly on the work map (which was a general highway and transportation map of each of the 3,070 counties). Corporate limits are definite boundaries and their location can be obtained. Populated areas or places that are not incorporated do not usually have definite boundaries. We therefore set up some rules for establishing boundaries for such places:

(i) The place or area should be kept as compact in area as possible and yet should include everything that is distinctly "non-open-country" in appearance.

(ii) Boundaries should be chosen that can be easily identified in the field. Therefore, wherever possible, boundaries were made to follow roads, railroads, streams and to a less extent survey lines.

(iii) Where satisfactory "natural" boundaries did not exist but where aerial photography was available, arbitrary lines were used. Where aerial photography was not available, rule (i) was relaxed.

The selected boundaries were drawn on the work map in green so that the unincorporated stratum could be readily distinguished on the map from the other strata. Similarly, the corporate limits were outlined in yellow.

The primary strata defined in this manner have served and will serve several purposes:

(i) Farms in the more densely populated areas, which we have reason to believe differ importantly from those in the more open areas, are assured their proper proportion in the sample;

(ii) Those areas which contain large non-farm populations relative to their farm populations are accurately designated, permitting a convenient means for selecting sampling units in these areas suitable for population and related types of samplings; and

(iii) A reasonably efficient use was made of available information, such as that of the census for incorporated places and the map culture for the number of and location of farms in the open country stratum—the unincorporated stratum being the one in which information on either farms or population was least available.

Sampling within the open country stratum.—The general highway and transportation maps which were obtained for all counties in the United States show, with variable degrees of accuracy, the location of farmsteads and other dwellings in the open-country areas and to some extent in the smaller unincorporated places. These farm and non-farm dwelling indications, which together with other structure indications are generally called by the mappers "culture," were used as a measure of size for determining numbers of sampling units to be assigned a given

area and to control the size, in terms of indicated farms and dwellings, of each. To utilize this information efficiently for these purposes it was decided that the farm and non-farm culture be counted and tabulated in such a way that it could be conveniently used. A unit of counting was therefore established. This is referred to here as the "count unit," which is a "natural" bound area, except where minor civil division boundaries were used, and which includes a minimum of six farms of eight dwellings and a maximum of about thirty farms. These limits were established for three reasons: (i) A large number of natural bound area segments, when inspected on maps, appeared to contain from six to thirty farms; (ii) The amount of work required was held at a minimum because, as will be shown later, much time was saved in the delineation of sampling units; and (iii) The resulting unit is of convenient size for some kinds of sampling where prelisting and subsampling schemes are desired. The average size count unit for the United States contained 10.9 farms. Within each minor civil division as a stratum, natural bound area segments were combined (by appropriate markings) whenever necessary to bring the total count to the minimum six farms or nine dwellings. Each minor civil division having open-country area was assigned at least one count unit even if fewer than six farms were indicated. The operating ceiling of thirty farms was relaxed if adequate boundaries for subdividing an area segment were not available.

For each count unit, the number of farms and the total number of dwellings (including farms) were marked on the map within the count unit area. These counts were made for all open-country areas. Every square mile of area in this stratum is covered by some count unit or units regardless of whether or not farms were indicated on the map within that square mile. Each count unit was numbered serially beginning with number one in the upper right-hand corner of each minor civil division and in a serpentine manner (such as sections are numbered within a surveyed township) throughout each minor civil division. The minor civil divisions were numbered in a similar manner within the county.

With the counts made and designated on the maps the next step was to determine the number of sampling units to be assigned to each count unit on the basis of this count information. Giving consideration to the problem of finding on the maps sufficient identifiable boundaries for small areas, it was decided that three general regions be set up in the United States within each of which a different average size of sampling unit would be sought. In region number one, which was largely in the Corn Belt, it seemed feasible to seek an average of four farms with in-

dividual sampling units permitted to vary from two to six farms in size, that is, a tolerated variation of ± 2 farms. In region two, the areas outside the Corn Belt but still within the Public Land Survey System, an average of five farms ± 3 farms per sampling unit was thought feasible. In region three, which included all other areas of the country (those not covered by the Public Land Survey System), the goal was set at six farms ± 4 farms per sampling unit. In areas not covered by aerial photography an attempt was made to obtain an eight-farm average and the tolerance relaxed to ± 6 farms, although some cases were left to individual circumstances.

These sizes, together with the tolerances, were the results of an attempt to strike a suitable balance between the smaller area which is usually statistically more efficient and the larger area which is less costly to enumerate (per farm) and prepare for, and which generally has fewer problems of boundary identification. Although some study has been made of these problems [7], [8], a considerable number of new situations required the quick and ready answers of judgment, the correctness of which can and will be evaluated by studies now under way and by subsequent experience.

Because the culture indicated on the county highway maps was of variable accuracy (when checked with 1940 census data), it was thought advisable to check the extent of the inaccuracy so that the expected number of farms per sampling unit would be based on the 1940 Census rather than on inaccurate culture. As an example, suppose the culture on a map under-represented census farms by 50 per cent. To avoid the possibility of getting sampling units that had twice the average number of farms desired, the number of sampling units assigned to each counting unit was therefore based on half rather than the full number of indicated farms. Another criterion for determining the size of the sampling unit was the extent and quality of identifiable boundaries considering, of course, the availability of aerial photos. In order also to provide for a satisfactory sample of population in this stratum, the expected number of dwellings per sampling unit was kept, wherever possible, to ten or less.

Tables were set up so that the clerk, knowing the regional location of the county, the culture count and its degree of inaccuracy, could select the suggested number of sampling units (and the permissible sizes of each) to be assigned to each count unit. This result was modified if inspection of the count unit on the map showed that an improvement in boundaries, accessibility or photo use resulted from such a change. When the number of sampling units for a counting unit was determined,

it was recorded on the map alongside the counts. Map data on counts and number of sampling units were then transcribed to listing sheets on which data for each counting unit were listed individually. These data were then punched on machine cards and a tabulation made for each county showing the following: the state code, county code, the minor civil division code, the counting unit serial number, its farm count, its dwelling count, its assigned number of sampling units, the cumulative totals for the two counts and sampling unit numbers. Count units on the tabulation were ordered serially within minor civil divisions which in turn were serially ordered within the county.

With the cumulative totals of sampling units indicated on the tabulation sheet, it was a relatively simple operation to designate the count units which would contain the required sampling units. A random number between one and eighteen was chosen as the starting point and the count unit containing every eighteenth sampling unit was designated on the cumulative total column on the tabulation sheet. The scheme of numbering count units within minor civil divisions and minor civil divisions within the county made possible the ordering of count units on the tabulation in such a way that geographic distribution of the sampling units would be maximized by this kind of systematic selection. The count unit selected in this way was then located on the map, and its subdivisions into the appropriate number of sampling units were so indicated that each sampling unit could be identified. Only those count units selected in the sample required actual subdivision into sampling units. This saved considerable clerical time. If the number of sampling units within a count unit was large, each sampling unit was numbered; if small, a systematic scheme of counting was followed. The sampling unit for the sample was chosen by selecting a random number from one to the number of sampling units in the count unit. The selected sampling unit was appropriately marked on the map and coded for future reference.

Sampling within the unincorporated stratum.—In the unincorporated stratum we were concerned with selecting a sample of farms without regard to its adequacy as a sample of population. Information as to the number of farms expected to be found within each of the unincorporated places was not shown by the maps as adequately as it was for the open country. It was therefore necessary to set up some rather arbitrary criteria for assigning the number of sampling units to each of the unincorporated places. These rules were: (i) A number of sampling units was so assigned that the expected number of farms per sampling unit was six; (ii) A minimum of two sampling units was required for each

unincorporated place regardless of how few farms were indicated. The number above this minimum was determined by the culture count of farms, with adjustment when it appeared advisable; (iii) The number of sampling units assigned by rules (i) and (ii) was modified when necessary to utilize most effectively identifiable boundaries shown by the map. In some cases it was necessary to make arbitrary decisions as to the number of sampling units a place should have because no culture at all was shown on the map. It was found that the culture shown around densely populated areas did not sharply discriminate the farm from the non-farm dwelling. In some cases where the unincorporated stratum included a large area, it was found convenient to sample it in a manner somewhat similar to that of the open country. In this case count units were established and counts (of farms only) made to help determine the distribution and number of sample units.

Lists were prepared which grouped the unincorporated places into three size groups: (i) from 100 to 499 population, (ii) from 500 to 999 population, and (iii) 1,000 population and over. In addition to the name of the place, this listing showed its population, its expected number of farms, the number of sampling units into which it would be divided, and the cumulative total of sampling units through the three size groupings. Taking a number between one and eighteen for a random start, a sample was selected systematically from the cumulative column of sampling units in much the same manner as was followed in sampling in the open-country stratum.

Sampling within the incorporated stratum.—As in the case of the unincorporated stratum, a listing was made of all incorporated places within each county, grouped into the two size groups—those under 2,500 population (rural according to the 1940 census) and those 2,500 and over (urban). From special tabulations provided by the Bureau of the Census the number of 1940 census farms for each incorporated place was obtained. Consequently, there was much better information on the expected number of farms for the incorporated places than for the unincorporated places. Each incorporated place was assigned a number of sampling units so that the average number of farms per sampling unit would be approximately six. With the sampling units so determined, sampling followed the same procedure as stated for the unincorporated stratum. Where incorporated places included an especially large number of farms, we obtained (from the Bureau of the Census) special enumeration district information for the location of those farms within the city. It was therefore possible to divide the city by enumeration districts in such a manner as to get a fairly equitable number of farms for each sampling unit.

Use of aerial photography.—The relatively small sample areas used in the Master Sample were made possible by aerial photographs, both the individual prints and the reproduced indexes. These served as detailed maps helpful in providing identifiable boundaries for designating sample areas and for use by the enumerator in finding those boundaries in the field. The scale of the ordinary aerial photograph is three inches to the mile and can be increased by the enlargement process to provide the necessary detail for showing sample area boundaries to the enumerator. Proper boundary identification is crucial for the prevention of possible bias in the improper inclusion or exclusion of farms for sample enumeration. The aerial photograph provides many useful landmarks, such as buildings, fence lines, clusters of trees, creeks, etc., which even the best detailed maps do not show. Although in areas covered by the Public Land Survey the sampling areas are generally more easily identified from ordinary maps, it was felt that even here aerial photographs are worth their cost. In areas not covered by the Public Land Survey the photographs are almost indispensable if the smaller, more efficient sample area is to be used.

For all sample areas in the open country the standard contact print of three inches to a mile was used to designate the sample area. In areas around villages and towns or within villages and towns, enlargements ranging in scale from 4¼ inches to 9 inches to the mile were used to provide the greater detail desired. The usual contact print measures either 7 by 9 inches or 9 by 9 inches. It covers, therefore, from 7 to 9 square miles of area. Although the majority of sampling areas required but one aerial photograph for complete coverage, on the average it was necessary to purchase about 1½ prints per sampling unit. Aerial photos were obtained for over 91 per cent of the sampling units in time for the 1945 Census of Agriculture.

Techniques of using the Master Sample.—Sampling areas provide a convenient flexible base for sampling different elements. For instance, if a selection of farms is desired, all that is necessary is that criteria be set up so that each farm is associated with but one and only one sample area. This can be easily accomplished in the majority of cases by regarding a farm as associated with a given sampling area if its headquarters falls within that area. Where farms do not have distinct headquarters, rules can be set up which will establish a sort of pseudo-headquarters suitable for these sampling problems. Other types of surveys may require some different criterion of enumeration. As an example, for certain crop estimates it may be desirable to include in the sample area only those fields or areas actually contained within the boundaries of the sample area, regardless of where the boundaries of the

farms within which they are located happen to be. In this case the aerial photograph is particularly useful because boundaries can be established exactly and the desired areas may be easily planimetered.

What the Master Sample is at present.—The Master Sample at present consists mainly of materials. These are of two kinds: (i) 3,070 count maps (one for every county in the United States) on which sample areas have been designated, providing, when enumerated, a sample of about three hundred thousand farms, and (ii) materials useful for drawing samples so that the present kind of sample can be extended or supplemented for any samples either of agriculture or of persons. The Master Sample does not yet have any data on the farms selected. The bulk of these data is expected to be obtained by the 1945 agricultural census and will be made available for sampling purposes soon after the field work has been completed.

The Master Sample materials at present consist of large scale (usually one inch to the mile) highway maps of all counties of the United States with information on them useful for sampling; listings of all towns, villages, cities and other densely populated places and areas having an estimated population of one hundred persons or more; tabulations of the expected numbers of farms and dwellings by small geographic areas (count units) and their cumulative totals; materials by which an unlimited number of county maps showing sample areas for a three hundred thousand farm sample can be reproduced (by means of the ozalid process); and aerial photographs for about 91 per cent of the 67,000 sample areas of the Master Sample.

Additional valuable materials for subsequent sampling will be made available when the 1945 agricultural census is completed. The Bureau of the Census will take a standard farm schedule from all farms and an additional supplemental schedule for more detailed information on farms in the Master Sample areas and specially designated large farms. Both schedules taken from the Master Sample farms will be coded accordingly during the regular census tabulation procedure. When punched on cards, these data will be useful for drawing both the general and the specialized types of farm samples for subsequent inquiries. With this information it will be possible to direct more efficiently the sample for specific inquiries to those farms most relevant to the inquiry. For instance, an inquiry of dairy farmers can be designed such that the enumerator is directed primarily to those sampling units having dairy farms because we will know, from the census information, which sample areas contained dairy cows at the time of the agricultural census. Changes taking place on the sample areas through time do not impair

the validity of sampling if appropriate designs are used. In fact, using the sample to measure change directly is usually an efficient way to estimate changes in the whole population.

Present plans for extending the Master Sample.—At present the Master Sample is an adequate sample of both farms and population in the open country stratum only. Work is now under way to extend the sample so that it will provide, by means of a supplemental selection of smaller areas with an average of 8 to 10 dwelling units per area, an adequate sample of persons in the unincorporated stratum. This work is being carried out jointly by the Bureau of the Census, the Bureau of Agricultural Economics and Iowa State College. The extension will follow the same general method of sampling, that is, the use of small areas clearly designated on maps, but the size of the unit will be measured in terms of total dwelling units rather than farms. In some areas where adequate maps and aerial photography are not available, it will be necessary to adopt a prelist-subsample scheme to reduce the number of dwelling units enumerated in any small sample area and therefore to increase sampling efficiency. The use of this device, however, will be held to a minimum because of its relative costliness. This work is designed to prepare a sample in unincorporated strata suitable for use in sample surveys of population, households and related subjects and for the proposed sample of population in 1946.

Other plans for the improvement and extension of the Master Sample, which can be briefly summarized here, call for:

(i) The completion of the charting of the areas covered by aerial photography and the completion of a set of indexes showing for any given area the appropriate print or prints covering that area. When this is done, the Bureau of Agricultural Economics will have the most complete and centralized source in this country of such information useful for obtaining aerial photography.

(ii) The use of 1945 agricultural census information for the classification of the farms on the Master Sample are as useful for future sampling inquiries. Perhaps a classification of areas will be made for similar purposes.

(iii) With the Bureau of Agricultural Economics, Bureau of the Census, and Iowa State College cooperating, a program of research is underway on sampling and estimation procedures which is designed to make the Master Sample more efficient and adaptable. This program will include a study of such problems as the efficient selection of counties or other primary sampling units, the study of schemes for subsampling the present sampling units, count units or

combinations of both, etc., study of various estimation procedures, the study of designs involving matching sampling units on repeated visitations and various other sampling schemes.

(iv) Modification of the Master Sample to utilize new information, when it becomes available, to improve the present sample.

LITERATURE CITED

[1] Anderson, Oskar. "Description of the Bulgarian agricultural sample census," *Bulletin de Statistique*, Publ. Direction Gen. de Statistique de Bulgarie. No. 8. 1934. (Summary in French.)

[2] Frankel, Lester R., and Stock, J. Stevens. "On the sample survey of unemployment," this JOURNAL 37: 77–80. 1942.

[3] Gini, Corrado. "Une application de la methods representative aux materiaux des dernier recensement de la population italienne," *Bulletin de l'Institut International de Statistique* 23(2): 198–215. 1938.

[4] Hansen, Morris H., and Hurwitz, William N. "On the theory of sampling from finite populations," *Ann. Math. Statis.* 14: 333–362. 1943.

[5] Hoijer, Ernst. "Organization of the 1935–36 extraordinary census of Sweden," *Iowa Agri. Exp. Sta. Mimeo. Series* No. 3702. 1937.

[6] Holmes, Irvin. *Research in sample farm census methodology.* Part I: "Comparative statistical efficiency of sampling units smaller than the Minor Civil Division for estimating year-to-year change." U. S. Department of Agriculture, Agricultural Marketing Service. 1939.

[7] Jessen, R. J. "Statistical investigation of a sample survey for obtaining farm facts," *Iowa Agri. Exp. Sta. Res. Bull.* 304: 1–104. 1942.

[8] Jessen, R. J., and Houseman, Earl E. "Statistical investigation of farm sample surveys taken in Iowa, Florida, and California," *Iowa Agri. Exp. Sta. Res. Bull.* 329: 263–338. 1944.

[9] King, A. J., and Simpson, G. D. "New developments in agricultural sampling," *Jour. Farm Econ.* 22: 341–349. 1940.

[10] Mahalanobis, P. C. "On large-scale sample surveys," *Philosophical transactions of the Royal Society of London.* Series B. No. 584, 231: 329–451. 1944.

[11] Neyman, Jerzy. "On the two different aspects of the representative method: the method of stratified sampling and the method of purposive selection," *Jour. Roy. Statis. Soc.* 97: 558–606. Discussion, pp. 607–625. 1934.

[12] Shepard, J. B. "Selection of areas for sampling agricultural enumeration," *Jour. Farm Econ.* 19: 454–464. 1937.

[13] Strand, N. V., and Jessen, R. J. "Some investigations on the suitability of sampling Iowa Agriculture," Iowa Agr. Exp. Sta. Res. Bull. 315: 616–650. 1943.

OPPORTUNITIES FOR STATISTICAL WORK IN THE FEDERAL GOVERNMENT*

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The war has seen the statistical profession in Washington attain mature stature. Before the war most statistical work dealt with what the British call "descriptive" statistics—the counting of an entire population for the record, a process which requires little more than good sound arithmetic by way of technique. It is true that the Government had many administrative programs for which statistical summaries of operations were useful to show progress and to justify appropriations. For the most part, however, these statistics were descriptive statistics and were prepared for the record. This is not to belittle the role of descriptive statistics or to discount the need for summarized information for the record. These have a place, and an important one, in providing economic, political and social analysts with material for evaluating achievements and in making projections of various kinds.

The war, however, has forced statistics into a controlling place in the conduct of the war effort. Little time was available to collect statistics for the record; the pressing need was for the collection of statistics for immediate and direct use in the administration of war programs. This redirection of effort has changed our concepts of statistics, of the role and importance of statisticians and of the place of statistics in the total scheme.

The war program is one of control: the control of raw materials and components for specific uses, the control of manpower in critical production areas, the rationing of scarce consumer goods, the development and policing of price and monetary controls, and the allocation of scarce transportation. War control is much more far-reaching than the general sanctions which government uses in peacetime. Generally speaking, no manufacturer or worker is free under war conditions to avail himself of the choices which are normally open to him. Control of choices by the central Government must be exercised by administrative agencies, and administrative agencies in turn must themselves be controlled by superior agencies. The functions of the administrative agencies, and of the controlling agencies, cannot be exercised without an extensive use of statistics. Paperwork is the lifeblood of control organizations, of coordination, of joint action on a state, national or international level.

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In wartime statistics is the principal tool for the planning and execution of concerted military and non-military activities.

The new importance of statistical controls and recognition of the role of statistics in policy making—both for military and for non-military policy—are best shown by the high place that statistical planning units have achieved in organization charts. Organization charts are frequently more misleading than informative, but nonetheless they do show that top-side recognition has been given to statistical work. In the Army Service Forces, for example, the statistical control office which is responsible for drawing the specifications for the required statistical work is located in a top echelon in the office of the Commanding General. In the War Production Board the statistical function and the policy planning function have been indistinguishable: Many of the Board's basic policy decisions are based upon statistics and the conclusions drawn from them. The new offices engaged in contract settlement and in surplus property disposal have likewise recognized the central role that statistics must play in their operations, and have directed their first activities toward the development of statistical plans. Recent legislation, including that setting up the Office of War Mobilization and Reconversion, is plentifully sprinkled with reporting requirements: some of this legislation, in fact, contains little more than the authority to require reports.

These illustrations could be multiplied many times, but it is probably unnecessary to do so. I believe there is general recognition of the superior place which statistics has now as compared to its status before the war. This development is well summarized in the "Memorandum on Official Statistics," an analysis of the British attitudes regarding statistics, published in the *Royal Statistical Society Journal.* The principal conclusion of the article is as follows:

> There has undoubtedly been a decided change for the better since the outbreak of war. The statistician is now sought after as he never was in peace time, his advice taken and respected in quite a new way. It is, we think, now generally recognized that a war must be run on facts, and that the interpretation of numerical facts is an expert accomplishment. Furthermore, there appears to have been a significant shift of emphasis. Statistics are no longer a by-product of administration or a useful index of the results of a course of action. They are a necessary pre-requisite in framing plans and courses of action. The statistician is now not concerned mainly with post-mortems but with preventing post-mortems.

Against this background of improvement and recognition of the place of statistics, what are the problems of the statistician in the Federal Government? Broadly speaking, there are two principal needs to which

the Government must pay attention in the collection of statistics. First, it must obtain the information it needs to administer its progr ms. Second, it must fulfill the basic responsibility of a democratic government to supply the information needed for the maintenance of free enterprise. The responsibility of a government to give its citizens the facts they need as a basis for free and intelligent decisions is a concept which is completely lacking and denied in totalitarian states, but which has long been recognized, even though not always fully discharged, by this Government. One of the best examples of a successful program of facts for the guidance of individual entrepreneurs is the *Market News Service* of the Department of Agriculture. This Service attempts to provide current price and supply information on markets for individual farm products during the marketing season. The system is implemented by personal contacts, by telephone, by radio and newspapers. It provides the farmer with full information which he can use to decide how much to sell and where to sell it. It permits him to avoid unnecessary speculative risks. It promotes the widest possible distribution of business opportunities among individuals.

These two general functions of government statistics—that of providing information for the operation of government programs, and that of providing guideposts for the operation of free private enterprise—taken together offer almost unlimited opportunity for the further development of statistics as an instrument to promote national well-being. The future of statistical work in government and in business is very bright in the sense that this opportunity exists. Whether or not the opportunity presented is fully used depends almost entirely upon the ability of the statistical profession to adjust itself to this new situation. Statisticians have in their own hands the consolidation of advances already made and the possible advances which lie ahead.

In view of this opportunity and the fact that responsibility for developing the opportunity rests with the statistical profession, I should like to consider briefly what will be required of statisticians in the government service. If they do not meet these requirements, the future is not so bright as it might be otherwise.

In the first place, the government statistician must know what information is needed either for the administrative program under consideration or for distribution to individuals for the operations of a free enterprise system. This question may seem a simple one, but unfortunately it is not. With very few exceptions, the university courses in statistics assume that the data to be manipulated are available and the question becomes one merely of applying mathematical short cuts in

summarizing the characteristics of the data. In the field of economic and social action, of which we are now talking, one cannot presuppose the existence of useful information. It is necessary to formulate the concepts and definitions of information which will serve the purpose at hand. This means that the planning statistician must have a complete grasp of the subject matter field in which he is doing statistical work. The administrator of a transportation program, for example, will know in what general directions his program is pointed, but he will not know how to apply statistical methods to achieve his end. The statistician in the same field, unless he is completely competent in the subject matter field of transportation, will not know how to adapt his statistical knowledge to the problems at hand. Consequently, the successful statistician in such an area must either have a unique combination of abilities or be able to draw upon other persons who together could contribute all the elements of skill necessary for the job. This statement merely emphasizes what most of us are well conscious of: the fact that statistics is a tool for doing something else and not an end in itself. I believe this generalization would apply to administrative statistics, descriptive statistics, or any other kind of information. I think that the American Statistical Association might well take the leadership in developing within itself, or in government and industrial statistical offices, or in universities, a broadened concept of what the statistician must be in order adequately to know what information is needed for the immediate problem under consideration.

Secondly, the government statistician, whether he is dealing with administrative statistics or with statistics needed by the general public, must know how to get the information which he has decided is needed. This again calls for unique qualities, none of which as a rule are developed in universities. A great deal has been and is being said upon this general question and it is probably not necessary to develop the argument very far. I would like merely to say that the academically trained statistician conversant with a subject matter field may still fail in his mission if he does not know techniques and methods, if he does not know how to get information at a reasonable cost and in the quickest and easiest way. He has to be imaginative, he has to have a sense of public relations, he has to be a practicing psychologist, and he has to have knowledge of what records or facts are likely to be available about the universe to which he is giving attention. He must also be able to operate his project on a time schedule which fits administrative or other requirements. We have all had too much experience with good collections of information which became available too late to be of any use.

Finally, the government statistician has much to learn from his industrial counterpart in making his product simple to understand, forceful, and informative. In other words, he is faced with the job of selling his product to an administrator or legislator or to the general public. This technique of presenting statistical conclusions in easily digestible form was first applied, as far as I know, in the advertising business and relies for its success upon the very simple psychological fact that appearance and presentation can create interest and get attention. The war has produced a number of outstanding examples of a new-found ability to make statistics something more than endless tables of figures with qualifying footnotes. One of the best examples of making statistics dramatic was in the testimony before the Congress last year in support of the extension of the Price Control Act. I am sure many of you have seen reproductions of these charts, but if you have not I would urge you to look at them or to read the testimony of Mr. Bowles. Further examples of successful presentation of previously inarticulate facts can be found in many of the reports of the Army Service Forces and the War Production Board. I cannot urge too strongly that unless the government statistician increases his ability to make useful statistics easily understood he will fail to maintain his present status.

Looking toward the future, the opportunities in the Federal service are not solely dependent upon the ability of statisticians to consolidate their gains. One thing that governs the number of opportunities in the Federal service is of course the question of whether there will be more government or less. It is far from clear as to what the trend will be in respect to government's role in national economic and social affairs. The British, according to the "Memorandum on Official Statistics" which I mentioned, expect that the wartime trend will continue during the period of reconstruction and beyond. The memorandum states

> it seems to us an inevitable social development that the State will intervene on an increasing scale in the life of the community in future years, and therefore that an increasing amount of statistical information will have to be collected for ministerial guidance.

Regardless of the trend, a more central role is awaiting statistics since existing opportunities have not yet been fully exploited. In fact, I would say that almost negligible beginnings have been made despite the dramatic progress during the war. I think it is important to keep in mind that statisticians can make their own opportunities: their central role has been recognized, and is waiting for exploitation in the fullest sense.

OPPORTUNITIES FOR STATISTICAL WORK IN STATE AND LOCAL GOVERNMENTS*

By David M. Schneider

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The statistician of today is a far cry from the species so dismally painted by General Francis A. Walker in an address before the American Statistical Association, at a meeting held in Washington in 1896. The following sentences are quoted from his public utterances.

> I do not know of a single man now holding, or who has ever held, a position in this country as the head of a statistical bureau, or as chief of a statistical services, or as a statistician, who had any elementary training for his work. All those who have had anything to do with American statistics came into the service comparatively late in life, without any elementary training, sometimes taking up the most gigantic pieces of work . . . , simply with an interest in the subject as the only guarantee of their competency.

That statisticians as a group have since gained considerable professional recognition is reflected in a series of tabular data which the writer has recently received from the National Roster of Scientific and Specialized Personnel of the War Manpower Commission. During the national defense and war periods, this agency has established a comprehensive list of highly trained Americans possessing special skills in their respective fields. Although the present registration does not represent complete coverage of professional manpower, it nevertheless portrays the enormous amount and variety of scientific and specialized skills available in this country.

As of October 1, 1944, the registrations of the National Roster totalled nearly half a million, including 2,506 professional statisticians. The latter does not include a large number of registrants skilled in statistics but who claimed other principal professional fields of specialization, especially in the social, agricultural and biological sciences. The Roster reveals that the typical professional statistician is a male, 37 years old, with a college education. Two out of every five hold at least a master's degree, while one out of eight is in possession of a doctoral degree. The statisticians are affiliated with various industries, including manufacturing, finance and insurance, telephone service, colleges and universities, business, trade and professional associations, and governmental agencies. Their occupational functions include research, consultant service, field work, collection and analysis of data, college teaching, management, computing or machine methods and technical writing.

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It is thus evident that considerable progress has been achieved in the development of professional statistical personnel. No reliable or complete data, however, are as yet available in regard to the distribution of statistical staff among the various industries and opportunities for employment in a given field. The use of statistical personnel and employment opportunities in state and local governments comprise the theme of this paper.

The search for facts and figures.—The dearth of factual data concerning employment opportunities for statisticians in state and local governments prompted the writer to send questionnaires to the governors of 45 states and mayors of the ten largest cities. The three remaining states—New Jersey, New York and Pennsylvania—were covered through direct communication with key statisticians and research workers. The inquiry was directed to such basic considerations as the extent to which statistical workers were employed in governmental agencies, recent expansion of work requiring additional staff and future outlook. The states were also asked to indicate to what extent statistical personnel was employed in related activities on a local level and future prospects for increased staff in county or city agencies. Although the larger municipalities were requested to submit this type of information directly, it was felt that the reactions of the states to local situations might cast some light on interrelationships of the two branches of government in statistical and research activities.

Statistical personnel of state governments.—Replies to the questionnaire were received from 164 governmental agencies in 23 states having an aggregate population of 77,000,000, or 58.4 per cent of the total population of the United States. This coverage may be regarded as fairly representative of the country as a whole, since the sample obtained comprises states from all major geographic divisions, including the New England, Atlantic, Central, Mountain and Pacific areas. Furthermore, the similarity between the proportion of states and population covered would indicate that states of varying size are well represented in the survey.

The 23 states reported that 1,011 statistical workers, including 369 statisticians of professional grade and 642 statistical clerks, were on governmental payrolls in October 1944. In addition, there were 82 statistical vacancies among the state agencies, the number of unfilled positions for professional and clerical workers being almost identical. It is not known, however, to what extent these vacant positions are "frozen," how many are definitely limited to the duration of the war, or the number of vacancies which might culminate in more or less permanent appointments.

To obtain a nation-wide picture of the number of statistical workers in state service, the sample data were interpolated in terms of the aggregate population of the United States. Such projected figures are obviously predicated on the assumption that the states which did not submit reports employed the same proportionate staff as those which yielded the information. It is further assumed that the reporting states sent in complete returns and that agencies excluded from such reports had no statistical personnel. The latter assumption is not entirely justified, however, since some states which did not report on all governmental agencies within their jurisdiction probably excluded persons who were engaged in statistical work but did not carry the payroll title of statistician or statistical clerk.

On the basis of the sample data, it is estimated that in October 1944, 1,731 statistical workers of all grades were in the employ of state agencies. Parallel to this figure are 141 vacant positions for professional statistician or statistical clerk, many of which will probably be filled on a temporary or permanent basis in the not too distant future. On an overall basis, the 1,731 statistical workers comprise 632 statisticians and 1,099 statistical clerks. These figures indicate an employment ratio of approximately two statistical clerks to one statistician of professional grade. A priori, this ratio appears to be rather low in view of the fact that many statistical and research projects require an abundance of clerical assistance. There are many extenuating circumstances, however, which help to explain this phenomenon. A large number of statisticians devote a great deal of their time to the development of statistical techniques, historical research, qualitative or descriptive studies, or render consultant service, which do not call for an undue amount of clerical assistance. Furthermore, as mentioned previously, many workers who are not classified as statistical clerks are engaged in statistical activities on a full-time or part-time basis. For example, one state reported that in addition to the regular statistical staff, there are a considerable number of other employees who render statistical assistance, but who are designated on the payroll as accountants, account clerks, etc. Another state indicated that in the Department of Highways, a certain amount of statistical work is done by the engineers. It is also true that many of the statisticians perform clerical functions which cannot readily be isolated from the more complex statistical processes. Moreover, competent clerical help is not easily available at prevailing salary rates.

State departments of labor and industries employ the largest number of statistical workers, both technical and clerical. The nation-wide survey reveals that this group of agencies utilized the services of 26.1 per

cent of all professional statisticians and 26.3 per cent of all statistical clerks employed in state governments. The relatively large proportion of statistical personnel in the departments of labor is in large measure attributable to marked statistical and research activity in such fields as unemployment insurance, workmen's compensation, child labor, price levels, employment and payrolls, industrial accidents and diseases, and labor disputes. Public welfare departments occupy second position with respect to size of statistical staff. These agencies have on their payrolls 17.3 per cent of the aggregate technical staff and 12.5 per cent of the total clerical personnel. The statistical and research activities of the public welfare departments embrace the fields of public assistance, hospital and dispensary care, child welfare, institutional care of adults, and temporary and special institutional care for various groups of dependents. The health departments rank third, and employ 13.8 per cent of the technical statisticians and 10.3 per cent of the clerical workers. The major fields of statistical and research activity of these agencies relate to births, deaths and marriages, population estimates, local health services, reportable diseases, sanitation and public health nursing. Considerable research and statistical personnel are also employed by state departments of highways, agriculture, taxation, education, banking and insurance. Few technical statisticians, however, are employed in such state agencies as correction, mental hygiene, public works, commerce, civil service and executive departments.

Expansion of statistical staff.—Viewed in broad perspective, there has been a definite upward trend in the utilization of statistical personnel by state agencies. The multitudinous changes in our economic and social structure have caused the Federal Government to lean rather heavily on the states for various statistical and research data. Increased statistical activity, as manifest in periodic reporting and special studies, was particularly pronounced in the fields of health, welfare, labor, agriculture and banking. The states themselves, however, began to realize that "What's sauce for the goose is sauce for the gander." The wealth of factual material submitted to the Federal Government was gradually being utilized by the states in studies of internal operations, formulation of state and local policies, administrative control and introduction of new legislation. Furthermore, many states have been engaged in intensive fact-finding studies, quite independent of federal requirements.

The growth of statistical personnel in the state governments has been impeded somewhat during the national defense and war period. Many statisticians are in the armed forces while others are associated with various war agencies. That adequate replacements are well-nigh impos-

sible at the present time is illustrated in a report from one of the large states included in the survey. In this state, the War Manpower Commission is assisting the Division of Placement and Unemployment Compensation in its research and statistical work by making available 11 technicians and research assistants on a part-time basis. Nevertheless, 40 agencies in 13 states, or one-fourth of the agencies studied, reported increases of statistical staff during the past five years. Progress in this direction was reported by all types of agencies, particularly those relating to health, agriculture, and taxation and finance. Some of the specific reasons given for staff expansion are (1) more intensive work on forecasting revenue under the state fiscal program, (2) inauguration of a tax-mapping program, (3) studies of rate-making activities, (4) increased research in various health activities, including cancer, venereal disease, and tuberculosis, (5) increased demand by the Federal Government for data on present and prospective food supply to carry on the war, (6) statistical analysis of wild life data, (7) increased program for research in education, and (8) reorganization of state agencies and establishment of independent statistical units.

Opportunities for statistical work in state governments.—The prospects for increased employment of statistical staff in state governments appear to be bright. The prognosis in 16 of the 23 reporting states was considered favorable, although only 50 agencies were able to present concrete evidence of the need for additional staff. Some agencies were convinced that opportunities for statisticians were imminent while others anticipated a post-war boom in statistical and research activities. This optimisim on the part of the states is largely due to: (1) the large mass of statistical information collected by the states, only a small fraction of which is being currently analyzed and interpreted. (The function of statistics as a tool of sound management is gaining increasing recognition among administrators, legislators and other policy-making groups); (2) extension of governmental services with a resultant increase in research and statistical programs; (3) newly created functions likely to be assumed by the state agencies during the postwar period.

The types of increased services or new functions anticipated by the states which may result in expansion of statistical and research staff are summarized here for each major field of activity:

Health: Extension of tuberculosis control program; registration of marriages and divorces in the Health Department; expansion of public health programs; inclusion of general and special hospitals in a state-wide register and follow-up service; special research in the various types of cancer; development of emergency maternity and

infant care program; study of deceased veterans based on vital statistics to be obtained from the War and Navy Departments.

Labor: Extended research into occupational diseases; increased functions in connection with the provisions of the G. I. Bill of Rights, including the processing of claims for veterans' readjustment allowances; additional activities relating to workmen's compensation.

Public Welfare: Intensive studies of the residual relief load; development of techniques for the quantitative measurement of services rendered to maladjusted families; cooperation with public and private agencies in the rehabilitation of veterans; probable increase in relief loads during the postwar period.

Agriculture: Increasing irrigation; power development; increase in cold storage plants; electrical utilization in the home; soil conservation programs; extended mechanization of farms; increasing requests for data regarding dairying and food products.

Education: Postwar expansion of educational institutions and schools resulting from increased enrollments and governmental assistance in the education of veterans; development of programs of educational testing.

Taxation and Finance: More intensive analysis of revenues and expenditures; research projects relating to highway accidents and their control; development of tax-mapping program, including the installation of permanent card indexes of real estate ownership; new taxation problems, such as those posed by the airline registration.

Public Works: Planning and traffic studies in connection with the development of postwar highway programs.

Miscellaneous: Expansion of studies relating to state salaries and service rating; possible amortization of the state's liability with regard to teachers' retirement; increased statistical activity involving public and military relations; postwar program with regard to the conservation of fish and game.

Opportunities for statistical work in local governments.—Since only two cities replied to the mailed questionnaire, the discussion of opportunities for statisticians in the localities is largely based on information received from states represented in the study. Although the functions of municipalities do not include such broad activities as labor and agriculture, they nevertheless present a fertile field for the development of research and statistical programs. This is particularly evident in municipal activities relating to health, public welfare, taxation, education, probation, law enforcement, and planning. It appears that most

counties and cities have not kept pace with the states in the development of statistical services and utilization of statistical personnel. Although data are not available concerning the number of statistical workers employed in local governments, it is safe to say that the existing staff falls far short of the minimum requirement for sound administration.

Comments received from the states reveal that although practically all the municipal governments perform some statistical functions, relatively few technically trained statisticians are employed for such activities. Most of the statistical work of counties and cities is performed by accountants, clerks and other staff members who lack the skills required for proper analysis and interpretation of data. Furthermore, it is only in the very large counties and cities that separate statistical and research units have been established and these are generally understaffed. For example, one of the leading municipalities reports that only three professional statisticians and seven statistical clerks are on its payroll, although many more are urgently needed. The situation is particularly acute in its health department which maintains a division of vital statistics. This unit reports that the rapid expansion of the United States Public Health Service has made increasing demands upon it for statistical data.

In general, rather meager information was obtained from the states concerning the extent of utilization of statistical staff and employment opportunities for statisticians on a local level. It appears that the state agencies are not sufficiently aware of the statistical and research activities of the local governments, available personnel in each of the functional fields and future outlook. The facts outlined above, however, reveal some avenues which lie open for professional statisticians and statistical clerks.

Education and training for statistical work.—Opportunities for statistical work are often closely associated with qualifications for the job. A case in point is a recent examination for Junior Statistician conducted by the New York State Department of Civil Service. Of 64 individuals who reported for the written examination, 18 withdrew during the examination and only 6 passed. The factors contributing to the present scarcity of qualified personnel have already been mentioned. Nevertheless, the fact that only a small proportion of those deemed qualified to take the examination actually received a passing grade, would indicate a definite lack of statistical training.

Being empirically-minded, the writer asked the directors of research and statistics in several of the New York State departments for a brief description of the qualities which characterize a good statistician.

Nearly all agreed that the most essential attributes comprise a knowledge of theoretical statistical techniques, familiarity with their practical applications and an intimate knowledge of sources of information. Some also felt that a knowledge of the field of activity was desirable for proper analysis and interpretation of the data and the formulation of sound and practical conclusions. Others stressed the importance of background in mathematics, economics and the social sciences.

How may the statistician of the future receive that basic training which will enable him to become a valuable asset in state or local government? There is need for planned cooperation between the states and colleges or universities in the development of a curriculum for prospective statisticians which will incorporate the cumulative experience of the governmental agencies. Broadly speaking, such a curriculum would include statistical theory and other background subjects, laboratory courses including practical applications of statistical techniques, and a limited amount of field work. Cooperative arrangements might also be made for the development of suitable extension courses for promotion purposes and for workers in other fields who plan a statistical career. The training of statistical clerks would naturally require a simpler curriculum, involving in the main a brief course in elementary statistics and instruction in machine operation.

Similar procedures for developing statistical personnel could be employed by local departments that are within reach of educational institutions. Those remotely situated might find it feasible to participate in state planning for the education and training of statistical personnel.

Conclusion.—Although the foregoing comments relative to opportunities for statistical work in state and local governments are in the nature of forecasts and a certain margin of error is unavoidable, it must be borne in mind that statistical work is still in its infancy and hence subject to considerable expansion. Certainly the variety of activities of governmental agencies which must be constantly adapted to a changing economy presents a fertile field for well-trained statistical workers. The natural growth of the statistical profession, however, may be accelerated by improved attitudes and concepts as to the pragmatic value of operating and administrative statistics, organizational changes within governmental agencies and increased cooperative relationships between the statistical units of the states and localities. Following is an outline of some of the objectives and problems which might be given consideration:

1. Centralization of research and statistical functions in a single bureau or division of the state or local department. This unit should have direct lines of communication with the administrative

office and provide the operating units with the necessary statistical data and consultant service in the planning and execution of field studies.

2. Establishment of a central statistical committee similar to the Central Statistical Board of the United States Government, which would be instrumental in correlating the statistical and research activities of the several state departments.
3. Development of an index of statistical data produced by state and local governments. Such an index should include published material as well as statistical data which remain unpublished in the files for lack of funds or lack of time to prepare the data for formal release.
4. The inauguration of periodic regional conferences of state statisticians to discuss problems of common interest, such as the validity of certain statistical techniques, budget estimating, and the probable effect of federal and state legislation upon statistical and research programs.
5. Periodic conferences should also be held of state and local statisticians in related functional fields. Such conferences would tend to strengthen state-local relationships, increase the reliability of statistics obtained from the counties and cities and instill local confidence in the value of statistics and their practical applications.
6. Expansion of statistical field service by state agencies to assist the localities with their problems of record keeping and reporting.
7. The launching of demonstration projects for the development of comprehensive statistics in states and localities.
8. The publication of a periodic bulletin by a national agency which would impart information about current projects conducted by state and local governments, new techniques, and employment opportunities for statistical and research workers.
9. Cooperation of states and localities with appropriate educational centers in the education and training of statistical personnel.

Although the above objectives are rather wide in scope, they are not entirely new or impractical. A number of states have made considerable progress in the coordination of statistical data, development of new techniques, and improvement of professional relationships. That much still remains to be done is axiomatic. It must be borne in mind, however, that the statistical profession must continue to strive for a definitive goal, if it is to attract its share of the country's talent.

OPPORTUNITIES FOR TEACHING AND RESEARCH*

By Gertrude M. Cox
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The war has accentuated the demand for both applied and mathematical statisticians. Too long, statisticians have taken a subsidiary position, but now they have an opportunity to establish statistics as a science standing on its own merits along with mathematics, physics, chemistry, biology and the social sciences. Statistics is too frequently considered a branch of mathematics or an option in economics rather than a distinct professional field.

Today there are almost unlimited opportunities for statisticians as the demand is far above the supply. Consequently, individuals trained in related sciences are taking statistical jobs. It is hoped, in the shifting of activities from war to peace, that some of these well trained scientists will continue in the field of statistics. To do so, they will probably want further training in the subject.

The demand for qualified statisticians will continue for a long time. It will take several years of concentrated, united effort to train enough statisticians to fill positions now available for (1) teachers, (2) research workers in mathematical statistics, and (3) statistical advisers to research workers in other fields.

As previously stated, a great increase in the teaching and application of statistics has taken place during recent years. These developments have come about because the usefulness of established statistical methods has been demonstrated, and because new applications are constantly being found.

Teachers.—The present critical shortage of statisticians forces us to consider the pressing need for qualified teachers. It is quite well known that the standards for teachers of statistics have not been high enough. Better qualified teachers will result only when statistics is considered and accepted as a primary profession. Many college courses in statistics are being offered by various departments as an adjunct to their main field and taught by persons who received their professional training in some other science. Few individuals can excel in their own field and at the same time be well versed in statistics.

A sound college teaching program in statistics can be devleoped when the instruction is given by persons with major interest and training in statistics. The courses now being taught within various departments

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deal mainly with the applications of statistics to particular fields. For the most part, such courses are not well rounded, but contain those statistical concepts which the particular teacher happened to use in his own research. Since the fundamental statistical concepts are the same for all fields of application, the basic work should be presented by teachers who have specialized in statistics. College administrators are asking for teachers trained to coordinate and develop the science of statistics. A teacher who has had specialized training in statistics, giving full time to his statistics courses, will provide more efficient training for future research workers.

Teaching opportunities include handling regular graduate and undergraduate college courses in applied and mathematical statistics. A teacher in this field needs to be thoroughly trained in the fundamentals of mathematical statistics, familiar with the wide applicability of the tools, and then be able to present these concepts simply. Basic concepts of statistics are not easy to present to others.

Courses in any subject need to be revised frequently in the light of recent findings. This is especially true in applied statistics as it is a new field. The teacher should not be content merely to pass on information accumulated by others, but he should contribute thoughts of his own, and thus stimulate the thinking of his students.

In addition to college courses, a need for intensive courses for special research groups also exists. These groups of research workers who are using similar statistical tools and who are confronted with related problems can be brought together for instruction and help on their problems. Teachers are needed to organize and assist with such work conferences. Education of these research workers in the concepts of statistical theory need not include so much of the mathematical structure, but must include the logic involved. That is, it is necessary to develop an appreciation of the assumptions attached to each statistical tool to assure its correct use. Contacts with research workers who received their college training in statistics from teachers with only a minimum of training in this science, emphasize the need for trained statisticians to instruct research workers whatever their field of application. Educational institutions training research workers are realizing that they must offer courses in statistics, for they recognize that optimum efficiency in research involves the use of statistical principles and tools.

Opportunities are available for those who have the ability to teach plus a thorough knowledge of mathematical and applied statistics and an appreciation of research problems.

Research workers.—Professional statisticians who are not teaching full time are engaged either in research or in consultant work. What are the job opportunities in the field of research?

Statisticians with considerable basic training in mathematics are needed to investigate unsolved problems in statistical theory and to develop and test procedures for specialized fields of application. These workers should aim to place the most emphasis on research having a specific application to existing practical problems.

A few of these problems awaiting further consideration will be mentioned. For example, it is desirable to know more about the mathematical theory underlying systematic sub-sampling methods. There are unsolved problems in distribution theory. Randomness which is assumed in much of our theory often is not present when the observations are taken. Consideration should be given to the order of the observations and to corresponding tests of significance.

More research needs to be done on the development of experimental designs and sampling schemes to meet the experimental limitations forced upon investigators. These plans call for further development of the mathematical procedures for the analysis of the data secured. Hundreds of modern designs for agricultural sampling programs, for field, greenhouse and laboratory experiments, forest grazing, control of insect pests, crop yield tests, human nutrition, medical research, vitamin needs and food qualities along with chemical, physical and production experiments have been developed and tested. It has been possible to demonstrate that these new designs enable experimenters to obtain more accurate results in shorter time and at reduced costs.

Not only are investigators needed to conduct this research work in statistical theory but also to make the theory available to others. This can be done by means of monographs on statistical procedures. However, these monographs should be written in simple language with the practicability of the methodology illustrated with actual numerical data. The statisticians are writing not only for mathematicians, but also for research workers in other scientific fields. Too often research statisticians have developed a mass of practical theory of which even the applied statisticians are unaware. Even if they knew the theory existed it is so written that it is difficult to interpret.

Advisers.—In spite of complex theory, our modern statistical methods have gained wide acceptance. Quantities of reliable data are being accumulated by research people who have neither the time nor the training to enable them to evaluate their results efficiently. This creates opportunities for statisticians to secure positions as advisers

on the conduct of experiments, analysis of the data and interpretation of the results. Local, state and federal agencies, agricultural colleges, experiment stations, research institutes, and business organizations need these advisers.

Statisticians are needed to analyze data now being collected and to evaluate the results secured to date. On the basis of existing results better and more economical work can be done in the future. Under pressure of time, short-cut methods are being devised by statisticians now doing consulting work in connection with the war effort. If these methods are giving practical results, we need to know about them. These consulting statisticians are encountering questions on methodology with no time available to do the needed research. More trained statisticians are needed to consult with the research workers regarding the mathematical aspects of their problems and to suggest procedures.

For these consultant posts, the individual needs a thorough training in the fundamentals of mathematical and applied statistics, and he needs to be as familiar with the wide applicability of the tools, as does a teacher. In addition, the consulting statistician must be reasonably familiar with the techniques and subject material used by those who are seeking his advice. If one sprinkled a generous amount of common sense and tact in among the above qualifications, he would have a consulting statistician who would surely be professionally recognized.

It has been indicated that job opportunities for statisticians who can give advice are numerous. They are. What are the individuals and organizations doing now about securing this statistical advice? They are taking every opportunity possible to secure a little help from this source or that. They are writing and visiting the consulting statisticians who can be reached; they are reading books and articles. As has been said before, these groups want to hire statisticians.

As indicated in the above discussion, it is impossible to escape the conclusion that opportunities are numerous for statisticians to fill positions as teachers, research workers and statistical advisers. The statistical profession now has an opportunity to become recognized in the scientific world.

OPPORTUNITIES FOR STATISTICIANS IN INDUSTRY*

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Industry's present use of applied science and continued trend towards "scientific" operation is creating many opportunities for statisticians. The effort to fortify judgment with measurement has resulted in using data from investigations, surveys and experiments as bases for action.

The tremendous achievements of private enterprise have given this country the highest standard of living in the world, simultaneously creating mass production techniques with striking similarity of goods and services. Differences have thus become small, but important when multiplied by units produced. Variation has not been eliminated and the need for detecting small changes is greater than ever before. The demand for greater reliability of prediction is becoming more and more apparent.

The great technology created and applied by the last generation is tending to become more inadequate in solving current problems. Its contribution is truly enormous and should not be underestimated. Nevertheless, the weaknesses and failures inherent in the concepts and techniques of present technical methods are becoming increasingly appreciated. In 1940 more than 70,000 men were engaged in industrial research and development spending over $300,000,000 yearly. They were engaged principally in creating reproducible experiments or attempting to make reliable predictions about future phenomena. The notoriously high percentage of failures to successes in this class of work gives some insight into the number and reliability of predictions which presently are made.

Statistical ideology is still relatively unknown throughout industry. Executives, administrators, supervisors, technicians, and operators were trained in and think today with functional science based on the concepts of arithmetic and algebra. As the appreciation for the power of modern statistics grows, it is safe to predict that statistical ideas will ultimately be as commonly employed as chemical concepts are used today; and that the number of practicing statisticians (of one kind or another) working in industry will be equal to if not greater than the present number of chemists. Although today's industrial demand for statisticians probably exceeds the supply, much remains to be done before statisticians are utilized to anything like their full potential.

* A paper presented at the 104th Annual Meeting of the American Statistical Association, Washington, D. C., December 27, 1944.

Even when industry is distinguished from commerce and government the variety and breadth of its operations are vast. Small infrequent islands of statistical converts are scattered throughout the industrial structure. The promotional and educational work of the Office of Production Research and Development of the War Production Board and the Army Service Forces in the fields of quality control and acceptance sampling has had a salutary influence during the war. Unless the seed takes root, this work and much more like it will have to be done over again.

The purpose of this paper is (1) to describe some typical industrial statistical problems, and (2) to offer an estimate of industry's most pressing statistical needs. In a paper as short as this, description must be almost enumeration. It is understood, of course, that the problems set forth and the needs expressed are the writer's personal opinions based on his own experience.

Typical industrial statistical problems.—For the purpose of this paper, industry will be defined as the manufacture and distribution of goods. Manufacture begins with the specification of the product desired. What does the customer really need? What is the process capable of producing? How can an economic compromise between the needs and the capabilities be derived as the design goal at which to aim? What kind and amount of evidence is required to give assurance that the design quality has been met? Each of these questions poses statistical problems. In the manufacture of consumer's goods the customer is a population of individuals creating sampling and product testing problems. In the manufacture of industrial goods the customer is a population of process conditions where the difficulties of sampling and design of experiment are endless.

The estimation of normal process quality levels and the design quality limits beyond which product failure occurs is greatly assisted by statistical concept. The initial laboratory experiments, pilot plant operation, and finally commercial production create statistical problems in design of experiment, interpretation of data, specification of materials, inspection of materials, process control, quality reporting, development of significant tests, and calibration of instruments.

Statistical methods find many applications in industry other than problems concerning product quality. Cost and profit controls offer fertile fields. The methods of standard costs introduce concepts of controllable costs, endless refinement of measurement, and consequent variation. Statistical thinking is needed here to provide better bases for action and greater reliability of prediction. Cost estimating (like quality predicting) creates sampling problems. Material discrepancies

reflect both assignable and unassignable causes of variation peculiar to the particular process involved. The preparation and interpretation of accounting reports employ many statisticians today.

Industrial Relations are employing more and more statistical methods. Recruiting, placement, and training present problems of selection and classification where aptitude testing is beginning to pay dividends. Psychological and sociological statistical techniques are probably taught more extensively in the schools than are those pertaining to the engineering sciences. Problems in sampling employees and processes are introduced in the development of basic wage rates, production and quality incentives, and the standardization of performance of men and machines.

Operating statistics are widely used by management as administrative tools. They are badly in need of professional statistical assistance. Everyone working in this field is an amateur statistician. Report forms are multitudinous. Different divisions request the same information with consequent duplication. Definitions and instructions for reporting are nonexistent or confusing. Reports cannot be added together or are not submitted. Forms are poorly designed or difficult to interpret. Statistics are unreliable and badly presented. At least two sets of inconsistent data can usually be found on any subject.

The marketing function of industry has probably made better and more extensive use of statistical tools than manufacturing, although much remains to be done. The work of advertising agencies, trade organizations, and government has forced business men to develop some appreciation for a few of the simpler statistical concepts. Advertising agencies are learning to test copy and measure distribution. Trade associations and independent research agencies analyze markets. Many private corporations engage in setting sales quotas and incentives, forecasting, sales planning and product testing. All of these activities require statistical thinking for their effective prosecution. The general problem is one of sampling stratified populations, calculating statistics, and testing for differences or relationships.

Anyone with a reasonably broad industrial experience, exposed to even the simplest statistical concepts, must appreciate their industrial potentialities; this is especially true when the power of statistical method is added to that of present technical method. There can be little doubt that considerable statistical work has already been done in industry, that present-day opportunities are extensive, and that future possibilities are enormous.

Industry's statistical needs.—The rate at which industry's ultimate demand for statistical services develops will depend on the kind and

amount of promotional, educational, and research work planned and performed by groups such as this. There can be no question of industrial opportunity; rather there are problems of approach and development.

It is interesting to review the introductory methods practiced during the last 20 to 30 years which resulted in industry's current use of applied science and large force of specialists. First, original research created concept and method. Second, these ideas and techniques were taught in the schools. Third, educated, experienced men gradually moved into key industrial positions. Fourth, these executives recognized the need for applied science and made certain that adequate kinds and numbers of specialists were employed in their organization. There is little reason to believe that statistical concepts and methodology will be used broadly throughout industry until a similar process takes place. Whether the job can be done in more or less than 20 to 30 years probably depends on how soon curricula can be changed and how effective adult education can be made. Casual contacts with teaching staffs of technical schools suggest that a generation of teachers must be sold as well as trained before undergraduate education begins on a broad basis. Statistical ideas are presently taught only in universities and there primarily as applied to specialized fields. Little or no attempt is made to emphasize the broad applications of statistics, to teach it for itself as algebra and calculus are taught. Statistical method should be introduced in the high schools and occupy an important place in the curricula of technical schools.

Today's industrial needs cannot wait 20 to 30 years. To meet them, as well as to create pressure on the teaching machinery, a short cut is needed—adult education. There are a large number of university trained individuals in industry who, because of their practical experience, are acutely aware of the discrepancies between practice and theory. Said another way, the theory of functional science or technical method makes inaccurate predictions much too frequently. These graduates have invented useful devices for dodging the responsibility of inference and prediction, e.g., "if the plant could be as well controlled as the laboratory," "all other variables constant or equal," "tests on the samples were so and so," "the experiments performed produced such and such results." There is pronounced tendency to present raw data and everyone makes his own inferences and predictions.

These technical graduates are ripe for intelligent and constructive criticism of technical thinking. The writer's personal experience in this regard has been favorable. Men with graduate degrees varying widely in age and experience can be taught concept if the mathematics are not emphasized. Promotion through technical associations and manage-

ment organizations is one approach. Selling and teaching papers in the technical literature is another. These papers should emphasize the limitations and weaknesses of much present technical thinking, explain the way in which statistics fill the gap, and describe the broad kinds of problems to which they apply.

Industrial adult education badly needs more and better books. The excellent ones already written by authors with industrial experience are narrowed down to some particular subject like product quality and presuppose a very considerable statistical knowledge. In order to understand basic concepts, interested students have to read texts on mathematical statistics or applied statistics in unrelated fields. There is not enough critical discussion of present engineering or scientific techniques. There is insufficient discussion of the hazards involved in misapplying statistical tools such as the blind use of unique sample theory, inverse probability, problems of heterogeneity, spurious correlation, etc. The appearance of new books more accurately pointed at industrial needs will do much to assist adult education, and thus shorten the time required for broad industrial acceptance of statistical concepts.

The need for executive acceptance of statistics has been emphasized throughout this paper. On this industrial base will operate a very large number of college graduates freely using statistical concepts, a smaller number of applied statisticians, a still smaller group of mathematical statisticians, and finally a few mathematicians. The graduates with statistical training will find their way into all kinds of industry and work at all levels in the industrial structure. The applied statisticians will probably work within specific organizational units such as marketing, manufacturing, accounting, etc. The mathematical statisticians can probably best be used in a consulting capacity and will be found only in large industrial organizations. The same can be said for mathematicians.

As the industrial use of statistics increases, the need for expanding research in mathematics and mathematical statistics will be pronounced. Even now there are serious limitations and gaps in the theory. The training of research personnel must provide for increased load. Serious consideration should be given to proper liaison between industry and the creative mathematicians so as to insure solution of the most pressing problems.

Summary. There are potentially enormous industrial opportunities for all kinds of statisticians. Industry, in general, is not aware of statistical method. To exploit industrial needs, statisticians face promotional and educational tasks of great magnitude. Undergraduate training and adult education provide at least two approaches.

STATISTICAL TESTS AS A BASIS FOR "YES-NO" CHOICES

By Herbert A. Simon
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Recent years have seen an almost universal acceptance among statisticians of the basic philosophy which underlies sampling theory: that whenever a statistic is employed to estimate some characteristic of a parent population, an estimate should be made of the sampling variation to which this statistic is subject. The estimate of "reliability" or "significance" may take a wide variety of forms—from the simple probable error, to the chi-square test, the t test, the z test and the more general Neyman-Pearson tests of hypotheses.

Because of this emphasis on sampling fluctuations, it has perhaps not been sufficiently noted that there are decisional situations, some of great importance, where a statistic should be employed as a criterion of choice regardless of its "significance" or "insignificance"—where, one might say, an insignificant difference is better than no difference at all. It is the purpose of this paper to examine one such situation, to explore its implications for sampling theory, and to show that such situations can be handled within the framework of Neyman's general "operational" approach to the theory of statistical tests.

It is our aim to show that the traditional tests of significance generally become inapplicable in situations where statistical evidence is to be used as the basis for an immediate yes-no choice. Suppose that it is desired to choose between two alternatives, one involving greater cost than the other, that data have been gathered to determine which alternative is preferable, and that a non-postponable decision must be made—either alternative A or alternative B must be selected and there is no opportunity to gather additional data. It will be argued that under these circumstances the usual tests of significance are not the best criteria of choice between the two alternatives.

To make the problem concrete we will consider a situation where it is desired to choose between two agricultural treatments—two fertilizers, say—one involving greater cost than another.[1] The writer has found two references to this problem in the literature, both offering the same solution. I quote from one of these references:

> As a practical application of fiducial limits, consider the case where a treatment having been applied to a crop, the expense is in question. Suppose there is some substance whose only advantage is the resulting increase in

[1] For simplicity, an agricultural illustration is used throughout this paper. The argument is certainly not limited to that particular field of application. As a matter of fact, the author originally developed this approach in connection with a study of optimum case loads for social workers in a public welfare agency.

yield, and whose cost is equivalent to the value of c units of the crop. Then, if the increase in yield fails to compensate the cost, the treatment is a failure. The sample must furnish evidence that the population mean difference is greater than c. The lower fiducial limit is used. If $\bar{x}$ is the mean difference between treated and check plots in the experiment, with standard error $s_{\bar{x}}$ then $\bar{x}-s_{\bar{x}}t$ must be greater than c, t being the 5% (or 1%) level for the available degrees of freedom. If $c=\bar{x}-s_{\bar{x}}t$, there is little chance that the population mean difference is less than c. Finally, if the population mean difference were equal to c, the *average* yield would be increased just enough to pay for the treatment.[2]

Professor Snedecor's solution is certainly the one which is suggested by modern sampling theory, but I submit that it is not the best solution to the problem which is posed above. To discover why it is not the best let us examine some of the underlying assumptions.

What is the purpose of the experiment described in the quoted passage? Is it to determine (a) whether the hypothesis that the new treatment is worth its cost is clear beyond a reasonable doubt, or (b) whether the new treatment should be used on the next year's crop? The suitability of the t test to the first purpose will not be disputed. Whether we use Fisher's terminology of "fiducial limits" or Neyman's terminology of "errors of the first kind," we will conclude that the t test, as applied in the quotation, is an appropriate way to determine whether the superiority of the new treatment is clear beyond a reasonable doubt.

But what about the immediate question: shall I use the new treatment, or shall I not? Suppose that x exceeds c, but not significantly. We conclude that further experimentation is needed to determine with the desired degree of certainty whether the superiority of the treated plots is real, that is, whether it is due to a difference between the populations from which the samples were drawn, or whether it is merely the result of random variations in samples drawn from identical populations. Hence the significance test indicates whether further experimentation is needed, but for two reasons this may not be an adequate answer to the problem at hand:

1. The cost of refining the experiment so as to determine whether or not the difference is real may be prohibitive;

2. Even if further experimentations is possible, it may be necessary to make an immediate decision to guide action until the new experimental results are available.

Every person who uses statistics as a basis for reaching decisions which lead to action constantly faces problems of this kind. Treatment

[2] George W. Snedecor, *Statistical Methods* (Ames, Iowa; 1937), p. 60. Cf. Dr. M. J. Van Uven, *Mathematical Treatment of the Results of Agricultural and other Experiments* (Groningen—Batavia; 1935), pp. 49–51.

A or treatment B must be used; the person responsible for the choice wishes to know which is better; statistical tests show neither treatment to be "significantly" (say, at the 5 per cent level) better than the other.

How should this statistical evidence be translated into a rule of decision? There are at least four possibilities. (1) "It doesn't matter which you do." (2) "Take the least expensive, because the other isn't significantly better." (3) "Take the apparently better one, even though the superiority is in doubt." (4) "No recommendation can be made unless additional data are gathered and a new test applied."

Professor Snedecor's and Dr. Van Uven's procedure leads to the second course of action. Yet it is hard to see how the t test permits any conclusion to be drawn, save the fourth, and the fourth conclusion does not solve the problem—which is to make a non-postponable choice. Is there any more positive conclusion which the data permit to be drawn and which will solve the immediate problem of action? Our analysis will lead us to conclude that in this case the third course of action is the one which should be followed.

The answer is to be sought in a modification of the Neyman-Pearson theory of testing hypotheses.[3] Using this theory, a statistical test can be interpreted as a means for reaching a decision. Since this decision involves a risk of error—two kinds of error in fact[4]—it is the property of a good statistical test that it minimizes, in some sense, this risk. The various types of "most powerful" tests which have been devised are generally designed to control the risk of rejecting a hypothesis prematurely, at the same time reducing as far as possible the risk of accepting a false hypothesis. Tests of this kind are legitimately applied to prevent the statistician from resting his conclusions on insufficient evidence. They point to the need, if that need exists, for further investigation of hypotheses when the data at hand do not permit the correctness of the hypothesis to be determined with the desired degree of certainty.

These tests have an asymmetry which is also extremely useful in cases where the consequences of accepting a false hypothesis are much more serious than the consequences of rejecting a true hypothesis. For example, in testing the proposition that "this batch of drug does not contain a poison in lethal quantities," we would ordinarily be much more concerned that a lethal batch might be accepted than that an innocent batch might occasionally be rejected.[5]

In the specific problem with which we are dealing there is no such

[3] J. Neyman and E. S. Pearson, "On the problem of the most efficient tests of statistical hypotheses," *Phil. Trans. Roy. Soc.*, Series A, 702, Vol. 231 (1933), pp. 289–337.

[4] There is the risk that a hypothesis will be rejected when it is true (error of the first kind), and the risk that the hypothesis will be accepted when it is false (error of the second kind). In the symmetric tests to be proposed in this paper, the two types of errors become identical.

[5] J. Neyman, "Basic ideas and some recent results of the theory of testing statistical hypotheses," *Journal of the Royal Statistical Society*, Vol. 105 (1942), at p. 304.

asymmetry. That treatment is preferable from which we may expect the greater net yield (that is, value of gross yield less cost of treatment). The risk that we will use the more expensive treatment and discover that the additional yield is insufficient to cover the additional cost is not a more serious kind of risk than the risk that we will use the cheaper treatment and discover that its inferiority is greater than the cost difference. Any asymmetry which inheres in the situation is adequately recognized when we require that the more expensive treatment give promise of at least covering its cost.[6] There is no difference between errors of the "first" and "second" kind which justifies the additional requirement that the advantage of the more expensive treatment exceed its cost by a "significant" amount.

To deal with situations of this kind, the writer proposes the use of *symmetric* tests—tests which attach exactly the same significance to an observed advantage in net yield of the more expensive over the less expensive treatment, as is attached to an observed advantage in net yield of the less expensive over the more expensive. In another publication, the writer has shown that, when the populations from which the observed data are drawn can be assumed to be normally distributed with equal standard deviations, there exists a uniformly most powerful symmetric test, i.e., a test which will lead to incorrect decisions less frequently than any other symmetric test no matter which of the two treatments is really the better.[7]

To put the matter another way, if a person always uses the uniformly most powerful symmetric test in making choices of the kind described here, then the expected value of net yield in plots which he manages will be greater than if he employs any other symmetric test whatever. As a matter of fact an even stronger claim can be made for the uniformly most powerful symmetric test: that a person using this test will have a greater expected value of net yield than if he uses any *asymmetric* test whatsoever which is based solely on the evidence of a single sample.[8]

In the present case, the best symmetric test would consist in computing $\bar{x}-c$, in employing the more expensive treatment when this quantity is greater than zero (instead of when $\bar{x}-c>s_{\bar{x}}t$ as Professor

[6] It should perhaps be pointed out that the difference in cost between the two treatments should include *all* costs, not excepting interest and depreciation on investment to be made. This raises the troublesome question whether, in setting the depreciation rates, the risk should be included that after the investment has been made the treatment now thought preferable may be found the less desirable of the two on the basis of additional data, and may therefore be discontinued. Reflection convinces the writer that no allowance should be made for this risk, since in evaluating the desirability of changing a decision already made, these investments would be treated as sunk costs and would not count in the comparison.

[7] Herbert A. Simon, "Symmetric tests of the hypothesis that the mean of one normal population exceeds that of another," *Annals of Mathematical Statistics*, Vol. 14 (1943), pp. 149–154.

[8] *Op. cit.*, pp. 152–153.

Snedecor proposes), and in employing the less expensive when $\bar{x}-c$ is less than zero. The symmetric test, then, designates the choice of that treatment which gives the greater net yield, regardless of the amount of difference; while the t test designates the choice of the treatment with less cost, unless the higher-cost treatment has a significantly greater net yield than the other. If the decision is based on the symmetric test, the long-run net yield in a series of such decisions will have an expected value higher than if the t test is used.

At first blush this use, without regard to its statistical significance of the mean value, as a criterion of decision, seems contrary to the whole direction of progress in statistical theory and practice. Further reflection shows that this procedure is a logical corollary to recent developments in testing theory. Tests of significance were originally conceived as means of measuring the "degree of certainty" or conversely the "degree of doubt" of statistical conclusions. In some recent work, particularly that of Neyman, tests of significance have been treated, as they are in this paper, as criteria upon which decisions are based. Now decisions are all-or-none phenomena. Even the decision "to doubt" or "not to doubt" represents a clear dichotomy. Hence, statistical tests must give yes-or-no answers. If the decision to be made is whether one should continue to doubt (i.e. whether further data-gathering is necessary before acceptance or rejection of a hypothesis), then those statistics which are generally called "tests of significance" are the appropriate criteria of choice. When the question is one involving the immediate choice of a course of action, the symmetric test should be used.

One final comment may be added. Because of the ambiguity of the notion of a "best estimate," as that term is used in statistical literature, Professor Neyman has abandoned the idea of making a specific estimate of a population parameter in favor of his procedure of constructing a confidence interval which—it can be predicted with a definite probability—will cover the true value of the population parameter.[9] The example used in the present paper shows that in certain instances, at least, the idea of a "best estimate" can be given operational meaning. The best estimate of the mean of a universe may then be defined as that estimate which gives the uniformly most powerful symmetric test for the hypothesis that the mean of this universe exceeds the mean of another universe. A theory of estimation based on this definition would be simply a theory of symmetric tests.

[9] See, for instance, J. Neyman, *Lectures and Conferences on Mathematical Statistics* (Washington, D.C.; 1938), *passim*.

AN APPLICATION OF THE POISSON SERIES TO SOME PROBLEMS OF ENUMERATIONS

By F. M. Wadley

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The estimation of insect populations by sampling is often very important in insect pest control and crop production, both in evaluating control measures, and in determining the need for them. It involves general questions of enumeration statistics. Typically the resulting figures are numbers of organisms per unit (as plant or area) for a large number of units which constitute the sample. In the most efficient sampling, the sample is finely divided, the units therefore being small, and the numbers per unit are low, often with many zeros.

The first and simplest question with regard to such material is whether the species studied is present at all. This is a qualitative matter. The next question, quantitative in nature and very important in insect control, is that of the density of population. The discussion in this paper is concerned with population densities. It is very desirable in this connection to know the limits within which the density is being estimated by the sample. Characteristic of the situation is the fact that dense populations have greater absolute variation but less proportional variation, than sparse populations, when sampled repeatedly from the same material.

Two practical problems, in which biometricians can help, arise in many places to confront the sampler. In the first place, in many situations a sample composed of systematically distributed units is considerably more accurate than a random sample, because differences exist between various parts of the field, and the systematically distributed sample is more representative of these fluctuations than a random one. Now our common methods of evaluating sampling error rest on random distribution of units through the field of inquiry, but we cannot correctly estimate the sampling variation of the systematic sample by standard methods. Calculation as if the sample were random tends to overestimate sampling error. We can calculate sampling variance by a modified method for a restricted random sample, but not for the systematic one, which may be the most useful. Any light which can be shed on the variance of such samples will be helpful. Madow and Madow [4] have discussed estimation of variance of systematic samples, but their results are not yet in a form suited for the use of field workers; intraclass correlation is employed.

Second, the problem frequently arises of some limitation of sampling

in very light infestations. Investigators seem intuitively to desire to sample more intensively in such infestations than in heavy ones. This desire apparently has two sources, a feeling that the proportional rather than the absolute variation should be held down and a fear of missing an infestation altogether by taking too few unit samples. The first idea is debatable and will depend on the circumstances of the problem; in many situations it seems that the absolute rather than the proportional variation will answer the questions at issue.

The fear of missing an infestation must be studied further. Two questions are pertinent: (1) How dense a population could conceivably be missed altogether by a given sampling intensity? (2) How dense a population could be viewed as unimportant? The biometrician can help provide an answer to the first question; the sampler must have an answer to the second. If we can answer these two questions we can specify a level of sampling which will give pretty good assurance against missing a population that might be important, but which will avoid wasting time in the detection of unimportant populations.

THE MATHEMATICAL BASIS

In thinking of the sampling variance of the mean or of the total of a single composite sample, we have in mind the reproducibility of the statistic if taken over and over again. If there is no bias in the sampling method, the measure of variability in samples also indicates how near our sample value is to the true value. Sometimes we do actually take more than one sample, especially in exploratory work; such a procedure is valuable in developing or checking technique. Usually, however, we have only one sample of which we desire to know the reproducibility.

With these counts or enumerations we have some grounds for prediction of sampling variance, which is not true with measurements. If the original distribution of the population were random, the numbers in various units would be distributed in the well-known Poisson series ($P_{(x)}=e^{-m}(m^x/x!)$, where $x=0, 1, 2\cdots$etc., and m is the mean of x). Variance in this series is equal to the mean. The totals of groups of N units each will also fall in a Poisson series with variance equal to the mean total. As a rule, however, though the numbers in successive units show traces of a Poisson relation, they definitely depart from it. There is a tendency to cluster, and to show more zeros and high counts than would be found in a true Poisson series. Samples will reflect these tendencies.

It has been found, however, that the totals of successive samples will often approximate a Poisson distribution even when units within a sample depart from it widely. This will be found true when sampling

is very thorough, with each sample consisting of a number of small units well distributed through the material. The mathematical reason is found in the nature of the Poisson distribution as outlined by various authors (for example, Fisher [2]). The sum of a number of variates having a Poisson distribution is itself distributed in a Poisson series. This is true whether or not the probability is constant from variate to variate. Now, in each of the small subdivisions of the field of inquiry, successive sample units, being closely adjacent, should fall in a distribution close to the Poisson. Hence their total may be expected to have a similar distribution. While variation among units within a composite sample may be pronounced, successive samples will vary less than this variation would suggest because all important parts of the field of inquiry are represented in each.

We can, then, assure ourselves that our total count in a very representative or well-distributed sample, if repeated a number of times, would give us a Poisson series or something similar to it. The Poisson series has several mathematical characteristics which will be of help. The standard deviation is equal to the square root of the mean. When average numbers are fairly large (20–30 or more) the Poisson is near the normal distribution and is nearly symmetrical, with a relation between the standard deviation and the range similar to that in the normal. This leads to an idea of sampling variance. When total numbers are small, the distribution is not symmetrical, but some other characteristics are helpful. The expectation of zeros, ones, twos, etc., may be defined from the mean by the equation just given. It is found that if the Poisson has a mean of 5 or more, expectation of zero is very small, about 1 in 150. Even if the material departs somewhat from the Poisson there is a margin of safety. The most likely sort of departure is toward something like a "contagious" distribution (Neyman[5]). In the simplest form of this, where the variance is not over twice the mean, expectation of zero is less than 1 in 23 with a mean of $5(P_{(x=0)}=e^{-m_1(1-e^{-m_2})})$ where m_1 and m_2 are estimated from mean and variance as $(\bar{x})^2/(V-\bar{x})$, and $(V-\bar{x})/\bar{x}$, respectively. Thus, if we sample extensively by a representative method and get a total of zero, we can infer with some confidence that the true total is not likely to be as high as 5. This statement is best made by saying we can assert that the total is below 5, and our assertion will be correct in a large majority of such situations. This gives a basis for limitation of sampling.

APPLICATIONS AND TESTS

The discussion has given the mathematical basis for an attempt at meeting the two problems named—estimating variance of a single

representative sample, and limitation of work in unimportant populations. It remains to give practical applications and to test the inferences.

It must be emphasized that these inferences will not apply unless the sample can be made very representative, with each small part of the field of inquiry entering into it. This will not permit unrestricted randomness. The choice of units within the small parts of the field should be random (every unit having an equal chance of entering the sample), or at least objective (free from personal choice). Where a systematic spacing scheme is used, the total only is random, since position within each subdivision is fixed, but choice within subdivisions is objective. Thoroughness of distribution, insuring representativeness, is of great importance. It is obvious that a sample composed of only a few large units will not qualify for these inferences. The sample should include as many and as small units as is practicable. Where it is difficult to make the sample represent all parts of the material, the inferences should be applied with great caution or not at all.

Suppose we have a single well-distributed sample of an insect population; suppose that a square foot is the minimum practical unit, and that 50 well-distributed units give a total of 125 insects, or 2.5 per square foot. How near is this to the true mean? Applying the inference of Poisson distribution of successive sample totals, we estimate their standard deviation as $\sqrt{125}$, or about 11 insects. We will not usually expect a sample total to be over 2.7 standard deviations, or about 30 insects, from the true mean. Hence we tentatively infer the true mean to be likely between 95 and 155 (or roughly between 2 and 3 per square foot). An allowance might be made for imperfect Poisson distribution.

Again, suppose that our 50 units give us zero. We can infer that the true total is not over 5, which would be 0.1 insect per unit on the average; or we can state it as likely from 0.0 to 0.1 per unit.

We can invert this latter inference with profit where the situation calls for estimating the number of sampling units required. Suppose from past evidence that we regard an average density of 0.05 per square foot or less as unimportant. A density of more than 0.05 is of some importance and we do not wish to miss an infestation of this intensity. We hence specify sufficient sampling to give a total of 5 individuals or more if the density averages over 0.05; this will require 100 units. The last application should not be made in cases where it would cut the number of units so low as to interfere with thorough distribution.

A test of the first application was made on population counts of Japanese beetle larvae, reported by Fleming and Baker [3]. The original

figures were made available through the kindness of Dr. Fleming. The 4 plots were each of 2,500 square-foot units, 50×50 feet in dimensions, and averaged 19.15, 9.22, 5.15, and 2.76 larvae per square foot, respectively. In the first plot studied, 10 composite samples of 100 units each were taken. The plot was divided into 100 squares, each 5×5 feet, and each sample contained 1 unit from each square. Position of the unit in each square was the same throughout a given sample, being chosen randomly for each sample. Thus a grid was placed over the area. Rectangles 5×10 feet, giving 50 units in a sample, were also tried. These two schemes were applied to Areas 1 and 2. In the other two areas the random variance among units was not very much greater than would be expected from the Poisson, so systematic sampling seemed to promise little advantage. Standard deviations of numbers per square foot are indicated by Fleming and Baker as 7.44, 6.87, 3.53, and 2.43, respectively, so variances of random-sample totals can easily be estimated for comparison. Results are given in Table I.

TABLE I

RESULTS OF SYSTEMATIC SAMPLING IN UNIFORMITY COUNTS

Plot	Units per sample	True mean total	Range in totals, 10 samples	Variance		
				Calculated among 10	Expected Poisson	Estimated random
1	100	1915	1869–2009	2075	1915	5535
1	50	958	922–1026	996	958	2768
2	100	922	883–1028	1736	922	4720
2	50	461	402–521	1387	461	2360

This test indicates, as would be expected, lower variance among systematic than among random samples (columns 5 and 7 of table). It also shows that if the sampling pattern is well adapted to the local variations, the variance among systematic samples is close to the Poisson value, and a conservative use of the latter would not lead the sampler far astray. It would not warrant, however, the use of the Poisson variance as an exact substitute for sampling error.

Another preliminary test was afforded by population sampling on codling moth larvae in apples. Forty-one trees each furnished 4 fairly representative samples of 50 apples each, and worms per sample were counted. The samples were assembled into several composite samples, each composite sample containing a total of 2,050 apples, composed of one 50-apple sample taken at random from each tree. The totals of the composite samples showed a variance a little less than twice the Poisson

expectation. On the other hand, random sampling would have given a variance nearly 5 times that of the Poisson, as shown by between-tree variance.

A rough practical test was given the application to limitation of sampling by Mr. R. W. White of the Bureau of Entomology and Plant Quarantine's Division of Pink Bollworm Control. In discussing the problem of cotton-gin-trash inspection for pink bollworms, there are certain areas in which a density of 1 larva or less per 100 bushels of trash may not be a serious threat. Hence sampling was planned to give high probability of detecting any infestation of over 1 per 100 bushels, which, according to the standard setup, means inspection of 500 bushels in a community. Mr. White applied this standard to a number of past inspections which had run over 500 bushels and had shown some infestation. He checked them to see if infestation had been detected in the first 500 bushels run. There were 39 cases in all. Of 16 cases above the critical level of 0.01 larva per bushel, infestation had been detected in every case in the first 500 bushels. Total bushels inspected had ranged from 520 to 10,012 per locality, with from 0.02 to 7.46 larvae per bushel; density was below 0.1 in half the 16 cases. Of 23 cases at or below the level of 0.01 larva per bushel, infestation was detected in the first 500 bushels in 8 cases and missed in 15. Amounts inspected ranged from 569 to 25,325 bushels with infestations from 0.0002 to 0.01 per bushel.

This test lacks something in statistical refinement. On the one hand, the total count is limited, the 500 bushels forming a fair-sized fraction of the total sampled in each community. The population estimate from the total is not usually exactly the true one from the community (unless all is examined), and the first 500 bushels (part of the sample) may show a density somewhat more like that of the total sampled than that of the true value. On the other hand, because of seasonal factors the first 500 bushels often run actually lower in infestation than later material. On the whole, the test tends to give confidence in the application of the method in a practical problem.

Another example may be drawn from data published by Beall [1] (1942) in a study of transformations. Each of his first seven tables is from a randomized-block experiment, typical except that each treatment occurs *twice* at random locations in each block. The insect-population figures for a set of plots of a given treatment, 1 from each block, may be looked on as constituting a sample of the area, restricted so as to give 1 unit in each block. The duplicate sets may be looked upon as two independent samples of similar restriction. It is obvious that in each case a number of combinations can be arranged giving a set of n

plots, 1 in each block. For convenience, it is assumed that the arrangement of Beall's tables gives a random grouping, and that following his horizontal lines we can assemble a pair of composite samples. The hypothesis is that in spite of the variance between units within samples, the sample totals will not vary much more than the Poisson expectation because each represents the same subdivisions. Accordingly each of our "samples" is tested for homogeneity, with $n-1$ degrees of freedom; the two duplicate sample totals are tested with 1 degree of freedom. Beall's Tables 5 to 7 are not used because of the low population and low internal variance; his Tables 1 to 4 will give the hypothesis a test. The variance tested is really that between *blocks* within a treatment, and the totals are two counts from the same set of blocks.

The results are given in Table II; they confirm previous ideas that successive systematic composite samples of population counts, if very thoroughly distributed, tend to a Poisson variance. Chi-squares between parallel composite samples are usually nonsignificant, while among units in each sample they are usually highly significant.

TABLE II

TEST OF HOMOGENEITY WITHIN AND BETWEEN SAMPLES

Table no.	Treatment no.	Chi-square within treatments				Chi-square between a and b, 1 d.f.
		χ^2	D.F.	Sample a	Sample b	
1	1	22.5	9	22.3‡	16.9†	2.00*
	2	18.6	9	25.1‡	39.8‡	0.01*
	3	19.5	9	29.0‡	7.0*	1.03*
	4	16.6	9	16.2*	42.5‡	2.71*
	5	15.9	9	21.5†	14.0*	4.08†
	6	13.8	9	28.7‡	37.1‡	0.13*
	7	48.5	9	36.1‡	57.7‡	1.19*
2	1	24.2	9	35.0‡	31.9‡	0.46*
	2	15.0	9	49.9‡	8.4*	0.03*
	3	20.3	9	51.9‡	45.6‡	10.09‡
	4	14.6	9	40.1‡	49.8‡	2.88*
	5	17.8	9	82.3‡	24.3‡	4.27†
	6	15.2	9	17.0†	27.6‡	8.55‡
	7	40.6	9	51.3‡	53.4‡	4.14†
3	1	361.6	6	156.8‡	377.1‡	16.39‡
	2	30.4	6	234.4‡	197.5‡	1.04*
	3	224.4	6	625.2‡	210.1‡	0.86*
	4	10.9	6	102.3‡	52.4‡	22.89‡
4	1	250.2	5	895.7‡	41.9‡	5.03†
	2	56.2	5	239.0‡	224.2‡	65.86‡
	3	118.3	5	135.8‡	199.1‡	2.37*
	4	21.8	5	474.0‡	10.0*	15.10‡

* P = 0.05 to 0.95. † P < 0.05. ‡ P < 0.01.

SUMMARY AND CONCLUSIONS

Problems of sampling populations, as to estimating sampling variance of the efficient systematic composite samples, and limitation of sampling in sparse populations, are discussed. If sample units are very thoroughly distributed through the material examined, successive sample totals tend to meet the fundamental conditions for the Poisson distribution, even where units within samples depart considerably from it. This opens the way to tentative application of the known characteristics of the Poisson to the problems presented, where the sampling approaches the thorough distribution needed. The results of practical tests using actual data would not encourage the use of this variance as an exact estimate of sampling error, but would suggest that it may give a useful tentative idea where no direct estimate is available. The application to limitation of sampling work seems likely to be a very useful one; a level of sampling sufficient for detection of any important population can be estimated. The value of well-distributed, representative samples of population is emphasized by these considerations.

LITERATURE CITED

[1] Beall, G. 1942. "The transformation of data from entomological field experiments," *Biometrika* 32: 243–262.

[2] Fisher, R. A. 1941. *Statistical Methods for Research Workers.* 8th ed. London.

[3] Fleming, W. E., and Baker, F. 1936. "A method for estimating populations of larvae of the Japanese beetle in the field," *Journal of Agricultural Research* 53: 319–331.

[4] Madow, W. G., and Madow, L. 1944. "On the theory of sytematic sampling," *Annals of Mathematical Statistics* 15: 1–24.

[5] Neyman, J. 1939. "On a new class of 'contagious' distributions applicable in entomology and bacteriology," *Annals of Mathematical Statistics* 10: 35–57.

TEST OF THE SIGNIFICANCE OF THE DIFFERENCES OF PER CENTS OF EMERGENCE OF SEEDLINGS IN MULTIPLE FIELD TRIALS

By G. A. Baker
University of California at Davis

Throughout the United States and part of Canada experiment stations have been cooperating in field tests to determine the prevalence of certain fungi affecting peas and beans and the effect of certain fungicidal seed treatments on the emergence of seedlings. One uniform lot of seed is divided and distributed. Rows of 100 seeds are planted in randomized blocks with five replications for each fungicidal treatment, including a check with no treatment. Sometimes only a few, if any, of the local trials indicate significant differences between the treatments. If all the trials could be suitably combined or considered together, significance might be established, and the type of relation between protection and fungi prevalence could be made clear.

An approximate method of dealing with data of this kind has lately been given by Roessler and Leach.[1] These workers group together trials whose variances form a "homogeneous" group, and, then apply standard analysis-of-variance techniques to test for significance and to establish significant differences. Since, however, this method neglects "errors of the second kind," the smaller "homogeneous" groups suffer, in less degree, the faults of analysis of variance applied directly to the entire aggregate of local trials. Also, breaking the data into groups does not accurately show the probable progressive relation between treatments.

The *t*-test applied directly to the per cents or to probits runs into the very troublesome situation that the differences are not equally variable. In other words, when little or no infective agent is present there is very slight chance for variation of any kind; but when infection is higher, greater variation is possible.

The purpose of this note is twofold: first, to derive a test for determining whether one treatment is better than another on the basis of per cents furnished by multiple trials, with a definite specification of the alternatives to the equality of effect of treatments; hence, second, to indicate how such differences between treatments change with prevalence of the destructive fungi. The bases of the present development are

[1] E. B. Roessler and L. D. Leach, "Analysis of Combined Data for Identical Replicated Experiments," *Proceedings of the American Society for Horticultural Science*. Vol. 44 (1944): 323–328.

likewise two in number. The first is Neyman's[2] discussion of multiple trials, in which he considers the scatter diagram of yields in multiple trials under two different treatments. We shall use "local" and "multiple" in the same sense as Neyman; that is, local means a trial on a field, whereas multiple means a number of trials on widely separated fields. The second basis is a previous paper[3] on regression when the variability is not uniform.

Suppose we consider two treatments T_x and T_y and the per cents of emergence x and y, respectively, of seedlings under these treatments for a number, n, of widely separated localities. Then if there is no difference between the treatments, we should expect the observed points to be scattered symmetrically about the line $y=x$. In this case x and y play similar roles in that they are equally subject to error. Deming[4] suggests, in such cases, that the sum of the properly weighted squares of the perpendicular distances be made a minimum in fitting a curve to such data. Thus as alternatives to the hypothesis that the perpendicular distances are symmetrically distributed about the line $y=x$ we shall consider that they are symmetrically distributed about some line $y=a+bx$. If we select proper weights for the observed points, then the usual tests of significance can be applied; and we can be confident that our results will be a reliable guide in the choice of this or that treatment.

When none of the treatments are injurious or stimulating and the seed is good, one constant, a, can be eliminated from the equation specifying our alternatives.

The proposed method will be made clear by an example. The table gives the data for a multiple trial with two treatments on lima beans. We are here considering perpendicular distances. Perhaps, therefore, instead of the observed variables x and y, it will be clearer to consider the transformed variables

$$x' = \frac{x+y}{\sqrt{2}}$$
$$y' = \frac{x-y}{\sqrt{2}}. \qquad (1)$$

These are also given in the table.

[2] J. Neyman with the cooperation of K. Iwaszkiewicz and St. Kolodziejczyk, "Statistical Problems in Agricultural Experimentation," *Supplement to Journal of the Royal Statistical Society*. Vol. 2 (1935): 107–180.

[3] G. A. Baker, "Linear Regression When the Standard Deviations of Arrays Are Not All Equal," this JOURNAL. Vol. 36 (1941): 500–506.

[4] W. Edwards Deming, *Statistical Adjustment of Data*, John Wiley and Sons (1943), especially chapter 10, section 65; chapter 2, sections 15, 16, and 17.

If there is no difference between treatments, y' should be distributed symmetrically about the x'-axis. Clearly, the spread of the y'-values is much greater for small values of x', so that it is necessary to determine the appropriate weights that should be assigned to each y'. To do this we broke the data into six groups (five groups of five and one group of four, as indicated in the table) and computed the standard deviation for each group. These standard deviations will tend to be slightly too large because part of the variation of the differences of the means of the two treatments is incorporated into them. This situation is not considered serious: the groupings are fairly fine and we are interested only in relative weights. Also, small changes in weights do not greatly change the ratios of weighted sums.

These standard deviations were plotted, a line was drawn through them, and approximate values were read off. Using these approximate values to determine suitable weights, P_i, and employing the methods of the previous paper,[3] we obtain the following:

$$\begin{aligned} \text{Standard deviation} &= 13.95 - 0.09833x' \\ &= 0.09833(141.9 - x'). \end{aligned} \tag{2}$$

This equation represents the change in the standard deviations of the y'-arrays as x' changes. From this equation we compute the P's given in the table. We arbitrarily took the middle P as equal to 1. It is noted that 141.9 differs but little from 141.4, which is the value of x' corresponding to $x=100$, $y=100$; hence the standard deviations are approximately proportional to the distance from the point $x'=141.4$, $y'=0$ or $x=100$, $y=100$.

Snedecor[5] suggests that a logarithmic transformation is suitable when the group means and the corresponding standard deviations are proportional. It seems preferable, however, to proceed with a straightforward application of Markoff's theorem.[6]

Using the P's of the table as weights, we found as the equation best representing the relation between y' and x',

$$y' = -11.2625 + 0.085277x'. \tag{3}$$

The theoretical values determined from (3) are given as Y' in the table.

The weighted sum of squares, under our hypothesis that the treatments are equal, is 677.56, with 29 degrees of freedom. The weighted

[5] George W. Snedecor, *Statistical Methods*, Third edition (1940), especially p. 384. The Iowa State College Press, Ames, Iowa. 422 p.

[6] F. N. David and J. Neyman, "Extension of the Markoff Theorem on Least Squares," *Statistical Research Memoirs*. Vol. II (1938): 105–116.

sum of squares from the best-fitting line is 482.26, with 27 degrees of freedom. Hence to test the significance of the regression of y' on x' we compute $F=97.65/17.86=5.47$ with 2 and 27 degrees of freedom and find $P=0.01$. Thus we conclude that treatment T_y is better than treatment T_x.

OBSERVED, TRANSFORMED, AND THEORETICAL (FOR THE DIFFERENT HYPOTHESES) PER CENTS OF EMERGENCE WITH SUITABLE WEIGHTS FOR A COOPERATIVE MULTIPLE TRIAL OF TWO TREATMENTS ON LIMA BEANS (1942) FOR 29 WIDELY DISTRIBUTED EXPERIMENTAL STATIONS.

x	y	x'	y'	Y'	Y''	P
25.4	31.8	40.4	4.5	−7.8	−6.2	0.17
50.0	33.8	59.3	−11.5	−6.2	−5.1	0.25
42.2	43.4	60.1	0.8	−6.1	−5.0	0.26
44.8	42.4	61.7	− 1.7	−6.0	−4.9	0.27
46.8	43.4	63.8	− 2.4	−5.8	−4.8	0.28
44.4	47.6	65.1	2.3	−5.7	−4.7	0.29
51.8	47.6	70.3	− 3.0	−5.3	−4.4	0.34
64.2	37.8	72.1	−23.2	−5.1	−4.3	0.36
56.6	49.6	75.1	− 4.9	−4.9	−4.1	0.39
58.8	53.0	79.1	− 4.1	−4.5	−3.8	0.44
71.8	61.8	94.5	− 7.1	−3.2	−2.9	0.77
65.6	70.0	99.4	3.1	−2.8	−2.6	0.96
74.0	66.6	99.4	− 5.2	−2.8	−2.6	0.96
70.2	71.6	100.3	1.0	−2.7	−2.5	1.00
75.4	69.2	102.2	− 4.4	−2.5	−2.4	1.10
80.2	71.0	106.9	− 6.5	−2.1	−2.1	1.41
79.2	73.8	108.2	− 3.8	−2.0	−2.0	1.53
78.4	74.8	108.3	− 2.5	−2.0	−2.0	1.54
78.8	77.2	110.3	− 1.1	−1.9	−1.9	1.73
81.4	76.6	111.7	− 3.4	−1.7	−1.8	1.90
83.8	76.6	113.4	− 5.1	−1.6	−1.7	2.13
79.6	80.8	113.4	0.8	−1.6	−1.7	2.13
84.8	79.2	116.0	− 4.0	−1.4	−1.6	2.57
82.8	84.8	118.5	1.4	−1.2	−1.4	3.16
87.2	81.6	119.4	− 3.3	−1.1	−1.4	3.43
85.0	85.0	120.2	0.0	−1.0	−1.3	3.69
86.8	89.0	124.3	1.6	−0.7	−1.1	5.60
88.2	90.4	126.3	1.6	−0.5	−0.9	7.15
86.8	89.0	127.7	− 2.1	−0.4	−0.8	8.54

Let us assume that

$$y' = b(x' - 141.4). \tag{4}$$

We then find $b=0.06173$, which gives the theoretical values Y'' in the table. The reduced weighted sum of squares is now 486.72, which gives a reduction 190.84 for the one constant b. Thus $F=190.84/17.38=10.98$ with 1 and 28 degrees of freedom, and hence $P<0.01$. In other words,

the reduction due to the constant term is not significant. This may not be true in other cases.

For comparison, t^2 for the differences between x and y is 9.78 and for differences between probits is 10.52. The agreement between t^2's so calculated and our F depends, however, on the more or less uniform distribution of x' values, and no particular agreement can be expected in general.

Equation (3) expresses the relation between y' and x'. If the relation between x and y is desired, this equation can be expressed in terms of x and y by means of equation (1).

In conclusion: we have given and illustrated an adequate way to determine, for emergence trials, which of two treatments is better when application has been made over a region of widely varying conditions. When the probability of infection is small, it makes little difference which treatment we apply or whether we apply any. As the probability of infection increases, proper treatment becomes increasingly important. If no previous knowledge is available about the quantitative presence of the infective agent, the better treatment should always be applied.

For the case considered, both the means of the perpendicular distances from the line $y=x$ and the standard deviations of such perpendicular distances at a given distance from the point $x=100$, $y=100$ (along the line $y=x$) can be considered as proportional to this distance.

ON THE SUMMATION OF CERTAIN PROGRESSIONS USEFUL IN TIME SERIES ANALYSIS

By A. M. Niessen
U. S. Railroad Retirement Board

J. A. PIERCE[1] PRESENTED a general recursion formula for the summation of the following types of finite series

$$\sum_{x=0}^{n} x^r = 1^r + 2^r + \cdots + n^r, \tag{a}$$

$$\sum_{x=0}^{n-1} (2x+1)^r = 1^r + 3^r + \cdots + (2n-1)^r, \tag{b}$$

$$\sum_{x=0}^{n-1} (2x-n+1)^r = (1-n)^r + (3-n)^r + \cdots + (n-3)^r + (n-1)^r, \tag{c}$$

$$\sum_{x=0}^{n-1} \left(\frac{2x-n+1}{2}\right)^r = \left(\frac{1-n}{2}\right)^r + \left(\frac{3-n}{2}\right)^r + \cdots + \left(\frac{n-1}{2}\right)^r, \tag{d}$$

for $r=0, 1, 2 \cdots$

In order to compute by the recursion formula the value of, say,

$$S_8 = 1^8 + 2^8 + \cdots + n^8$$

it would be necessary to compute first $S_0, S_1, \cdots S_7$ in order to substitute the proper values for these terms in the formula for S_8. Thus for higher values of the exponent r the amount of the necessary work may become prohibitive.

The purpose of this note is to present a general method based on the calculus of finite differences which is believed to be simpler and much less laborious. For a better illustration of the actual processes involved two examples will be worked out in full.

We shall use the following familiar notations

$$\Delta f(x) = f(x+1) - f(x)$$
$$\Delta^p f(x) = \Delta^{p-1} f(x+1) - \Delta^{p-1} f(x)$$
$$x^{(p)} = x(x-1) \cdots (x-p+1).$$

The following well known theorems will be here recalled:

[1] This Journal, September 1944, pp. 387–389.

Theorem 1

A polynomial $P(x)$ of degree k can be expanded in the form

$$P(x) = P(0) + \Delta \frac{P(0)}{1!} x^{(1)} + \Delta^2 \frac{P(0)}{2!} x^{(2)} + \cdots + \Delta^k \frac{P(0)}{k!} x^{(k)}, \quad (1)$$

Theorem 2

$$\Delta x^{(k+1)} = (k+1)x^{(k)}, \quad \text{or}$$

$$x^{(k)} = \frac{1}{k+1} \Delta x^{(k+1)}, \quad (2)$$

Theorem 3

$$\sum_{x=0}^{n-1} \Delta f(x) = f(n) - f(0). \quad (3)$$

Consider now the series

$$S_4 = 1^4 + 2^4 + \cdots + n^4$$

whose general term is x^4.

The table of differences may be arranged as follows:

x	x^4	Δx^4	$\Delta^2 x^4$	$\Delta^3 x^4$	$\Delta^4 x^4$
0	0	1	14	36	24
1	1	15	50	60	
2	16	65	110		
3	81	175			
4	256				

By formula (1) we may write

$$x^4 = x^{(1)} + 7x^{(2)} + 6x^{(3)} + x^{(4)}.$$

Applying theorem (2) we obtain

$$x^4 = \frac{1}{2} \Delta x^{(2)} + \frac{7}{3} \Delta x^{(3)} + \frac{3}{2} \Delta x^{(4)} + \frac{1}{5} \Delta x^{(5)}.$$

Finally, applying theorem (3) we arrive at the formula

$$S_4 = \sum_{x=0}^{n} x^4 = \left[\frac{1}{2} x^{(2)} + \frac{7}{3} x^{(3)} + \frac{3}{2} x^{(4)} + \frac{1}{5} x^{(5)}\right]_0^{n+1}$$

or
$$S_4 = \frac{1}{2}n(n+1) + \frac{7}{3}(n-1)n(n+1) + \frac{3}{2}(n-2)(n-1)n(n+1) + \frac{1}{5}(n-3)(n-2)(n-1)n(n+1). \quad (4)$$

For practical purposes no algebraic simplification of the above formula is necessary.

As another example let us consider the series (b)

$$\sum_{x=0}^{n-1}(2x+1)^3 = 1^3 + 3^3 + \cdots + (2n-1)^3.$$

The table of differences is:

x	$f(x)=(2x+1)^3$	$\Delta f(x)$	$\Delta^2 f(x)$	$\Delta^3 f(x)$
0	1	26	72	48
1	27	98	120	
2	125	218		
3	343			

$$f(x) = 1 + 26x^{(1)} + 36x^{(2)} + 8x^{(3)}, \text{ or}$$
$$f(x) = \Delta x^{(1)} + 13\Delta x^{(2)} + 12\Delta x^{(3)} + 2\Delta x^{(4)}, \text{ and}$$

$$\sum_{x=0}^{n-1}(2x+1)^3 = \left[x^{(1)} + 13x^{(2)} + 12x^{(3)} + 2x^{(4)}\right]_0^n$$
$$= n + 13n(n-1) + 12n(n-1)(n-2) + 2n(n-1)(n-2)(n-3). \quad (5)$$

The applicability of this method to series of type (c) is apparent. If the method of finite differences is used a series of type (d) can be treated exactly in the same manner as type (c) since

$$\sum_{x=0}^{n-1}\left(\frac{2x-n+1}{2}\right)^r = \frac{1}{2^r}\sum_{x=0}^{n-1}(2x-n+1)^r.$$

The method outlined above is perfectly general and can be applied to numerous other types of finite series.

ELECTION OF FELLOWS

During 1944 the Committee on Fellows elected the following ten members of the Association for Fellowship:

HENRY B. ARTHUR, *Swift & Company*, is a director of the American Statistical Association.

A. E. BRANDT, *U. S. Department of Agriculture*, was Assistant Professor of Mathematics and Research Assistant Professor of Statistics at Iowa State College from 1924 to 1938; Senior Mathematical Statistical Analyst, Division of Research, Soil Conservation Service, U. S. Department of Agriculture, from 1937 to 1940; and Principal Soil Conservationist from 1940 to date. He has written on animal genetics, eugenics, biometry, soil and water conservation.

W. G. COCHRAN, *Iowa State College*, was Statistician, Rothamstead Experiment Station from 1934 to 1939 and Professor of Mathematical Statistics, Iowa State College from 1939 to date. He has written on mathematical statistics and its application to agriculture and biology.

GERTRUDE M. COX, *North Carolina State College*, was Assistant in the Statistical Laboratory, Iowa State College, from 1933 to 1939 and Research Assistant Professor there from 1939 to 1940. She is now Professor of Experimental Statistics and head of the department at North Carolina State College. She has written on experimental designs and statistical methodology.

PHILIP M. HAUSER is Assistant Director of the *Bureau of the Census*. He has written on technical statistical subjects.

FRANK LORIMER is Professor of Population Studies in the Graduate School of *American University*. He has written on social science and demography.

ISADOR LUBIN, *U. S. Commissioner of Labor Statistics*, has written on government control of prices, on wages and on unemployment.

CHARLES F. SARLE is Executive Assistant to the Chief of the *Weather Bureau*. He has also done statistical research in the Bureau of Agricultural Economics.

ALAN TRELOAR is Associate Professor of Biometry at the *University of Minnesota*. He has written on statistical biology, vital statistics and statistical method.

SEWALL WRIGHT is Burton Distinguished Service Professor of Zoology at the *University of Chicago*. He has written on genetics, biometry, statistical consequences of Mendelian heredity, and evolution.

At the beginning of 1944 there were one hundred and seventeen living Fellows. During the year two died.

JOHN R. MINER, *Chairman*

PROCEEDINGS

104TH ANNUAL MEETING

THE GEORGE WASHINGTON UNIVERSITY
AND WILLARD HOTEL
WASHINGTON, D. C.

PROGRAM

Wednesday, December 27, 1944

—9:30 A.M.—

JOB OPPORTUNITIES IN STATISTICAL WORK

Chairman: E. Grosvenor Plowman, United States Steel Corporation

Opportunities for Statistical Work in the Federal Governments
William R. Leonard, Bureau of the Budget

Opportunities for Statistical Work in State and Local Government
David M. Schneider, New York State Department of Social Welfare

Opportunities for Teaching and Research
Gertrude M. Cox, North Carolina State College

Opportunities for Statisticians in Industry
John B. Catlin, Kimberly-Clark Corporation

Discussion: Walter A. Shewhart, Bell Telephone Laboratories
Rufus S. Tucker, General Motors Corporation

PRESENTING STATISTICS TO MANAGEMENT

Chairman: Major Kenneth W. Haemer, Army Service Forces

Basic Considerations
Colonel John D. Witten, Army Service Forces

Controlling the Collection of Data
Major Joseph A. Moran, Army Service Forces

Operation of the Reporting System
S. P. Langhoff, Jr., Army Service Forces

Presentation of Statistical Material
Major Kenneth W. Haemer, Army Service Forces

Discussion

Wednesday, December 27, 1944

—1:30 P.M.—

CENSUS TRACTS CONFERENCE

Chairman: Howard Whipple Green, Cleveland Health Council

Census Tracts—Progress or Regression?
Philip M. Hauser, Bureau of the Census
Use Being Made of Census Tracts
W. Thurber Fales, Baltimore City Health Department
Laying Out the Metropolitan Districts of Census Tract Cities
C. E. Batschelet, Bureau of the Census
Use Being Made of Block Statistics
Kenneth C. Beede, Smaller War Plant Corporation
Relation of "Improvement Districts" to Census Enumeration Areas
Frederick Bigger, Pittsburgh Planning Commission
Use of Census Tract Data in Marketing Research
Floyd E. Brown, The Cleveland Plain Dealer
Discussion

THE TRAINING OF STATISTICIANS

Chairman: Harold Hotelling, Columbia University

Training for Work in Sampling
W. Edwards Deming, Bureau of the Budget
Training for Statistical Work in Agriculture and Biology
William G. Cochran, Princeton University
Training to Supply the Demand
Francis G. Cornell, Office of Education
Discussion: Donald C. Riley, Bureau of the Budget
Milton da Silva Rodrigues, National Statistical Council, Brazil, and Inter-American Statistical Institute
Aryness Joy Wickens, Bureau of Labor Statistics

RECONVERSION AND POSTWAR INTEREST OF BUSINESS IN STATISTICS

Chairman: F. Stuart Fitzpatrick, United States Chamber of Commerce

Some Problems of Basic Industrial Statistics
William J. Donald, National Electrical Manufacturers' Assn.
Construction Industry Looks at Its Statistics
William Muirhead, Associated General Contractors of America
Statistics—A Tool for Mitigating Business Fluctuations
Emerson P. Schmidt, United States Chamber of Commerce
Discussion: Miles L. Colean, Architectural Consultant
Milton Gilbert, Bureau of Foreign and Domestic Commerce
S. Morris Livingston, Bureau of Foreign and Domestic Commerce
Robinson Newcomb, War Production Board
Woodlief Thomas, Federal Reserve Board

Wednesday, December 27, 1944

—4:00 P.M.—

SELECTION AND CLASSIFICATION OF STATISTICIANS

Chairman: Morris A. Copeland, War Production Board

Placement Service of the American Statistical Association
Lester S. Kellogg, Bureau of Labor Statistics
Recruiting, Examining, and Placing Statisticians in Federal Service
Clayton V. Taylor, Civil Service Commission
Problems in the Classification of Positions of Statisticians
John L. Hickey, Civil Service Commission
Discussion: W. Edwards Deming, Bureau of the Budget
Donald C. Riley, Bureau of the Budget
W. R. Williamson, Social Security Board

RECENT DEVELOPMENTS IN SAMPLING

Chairman: W. G. Cochran, Princeton University

Some Recent Sampling Developments
William N. Hurwitz, Bureau of the Census
William G. Madow, Bureau of the Census
The Master Sample of Agriculture
Raymond J. Jessen, Bureau of Agricultural Economics
Arnold J. King, Iowa State College
The Census Sampling Program
Morris H. Hansen, Bureau of the Census

—7:00 P.M.—

THE ROLE OF STATISTICS

Toastmaster: H. R. Tolley, Bureau of Agricultural Economics

The Use of Statistics in the Formulation of a National Full Employment Policy
The Honorable Henry A. Wallace
Vice President of the United States
Presidential Address
Helen M. Walker, Teachers College, Columbia University, President of the American Statistical Association

Thursday, December 28, 1944

—9:30 A.M.—

MANAGEMENT OF FIELD WORK AND COLLECTION OF STATISTICS

Round Table

Chairman: J. C. Capt, Bureau of the Census

Discussion: Harvey E. Becknell, Bureau of Labor Statistics
Joseph Bevis, Opinion Research Corporation
A. Ross Eckler, Bureau of the Census
James C. Gallagher, National Analysts, Inc.
William McPeak, Army Service Forces

Thursday, December 28, 1944

—9:30 A.M.

INTERNATIONAL STATISTICS FOR RECONSTRUCTION

Chairman: Frank L. McDougall, United Nations Interim Commission on Food and Agriculture

An International Standard for National Income Statistics
Milton Gilbert, Bureau of Foreign and Domestic Commerce

A Proposed Statistical Program for the United Nations Food and Agriculture Organization
Joseph A. Becker, Office of Foreign Agricultural Relations

The Demographic Statistics of Southern and Eastern Asia
Irene B. Taeuber, Bureau of the Census

—12:30 P.M.—

LUNCHEON OF FELLOWS OF THE AMERICAN STATISTICAL ASSOCIATION

Chairman: John Rice Miner, Vice President of the American Statistical Association, and Chairman of the Committee on Fellows

Preliminary Report of the Committee on Fellows
Theodore H. Brown, Harvard University, Chairman of the Committee on Fellows for 1945

Discussion on the Functions of Fellows

—1:30 P.M.—

THE FEDERAL GOVERNMENT'S STATISTICAL PROGRAM FOR RECONVERSION AND POSTWAR ADJUSTMENT

Round Table

Chairman: Isador Lubin, Bureau of Labor Statistics

Industry and Business Statistics
M. Joseph Meehan, Bureau of Foreign and Domestic Commerce

Discussion: Rufus S. Tucker, General Motors Corporation

Population
Leon E. Truesdell, Bureau of the Census

Agriculture
Conrad Taeuber, Bureau of Agricultural Economics

Labor
Arnold Tolles, Bureau of Labor Statistics

CURRENT SAMPLING PROBLEMS

Chairman: Samuel A. Stouffer, Army Service Forces

Component Indexes as a Basis for Stratification in Sampling
Margaret Jarman Hagood, Bureau of Agricultural Economics
Eleanor H. Bernert, Bureau of Agricultural Economics

The Sample Census of Congested Areas
W. Edwards Deming, Bureau of the Budget
Benjamin J. Tepping, Bureau of the Census

Problems in Sampling Public Opinion
Edward G. Benson, American Institute of Public Opinion

Thursday, December 28, 1944

—4:00 P.M.—

ANNUAL BUSINESS MEETING. Reports and Election of Officers.

—7:00 P.M.—

MEASURES OF EMPLOYMENT IN RELATION TO POSTWAR PROBLEMS

Chairman: Howard Myers, Committee for Economic Development

Experiment in the Measurement of Unpaid Family Labor in Agriculture
Louis Ducoff, Bureau of Agricultural Economics
Gertrude Bancroft, Bureau of the Census
The Revised Census Series of Current Employment Estimates
A. Ross Eckler, Bureau of the Census
The Trend and Pattern of Urban Wage Rates
Robert J. Myers, Bureau of Labor Statistics
The Measurement of Postwar Labor Supply and Its Capacity to Produce
S. Morris Livingston, Bureau of Foreign and Domestic Commerce

PROBLEMS OF INTEGRATING FEDERAL STATISTICS

Round Table

Chairman: Stuart A. Rice, Bureau of the Budget

Discussion: Philip M. Hauser, Bureau of the Census
A. Ford Hinrichs, Bureau of Labor Statistics
H. R. Tolley, Bureau of Agricultural Economics

Friday, December 29, 1944

—9:30 A.M.—

NEW APPLICATIONS OF THE SHEWHART CONTROL CHART

Chairman: Joseph M. Juran, Foreign Economic Administration

Uses of the Control Chart in Connection with Navy Specifications
Lt. Walter C. Jacob, U.S.N.R., Bureau of Ships
The Control Chart as a Tool in Management
C. A. Bicking, Marshallton, Delaware
The Use of Statistical Methodology in the Procurement of Textile Materials
Lt. Col. Frank M. Steadman, Philadelphia Quartermaster Depot
Discussion: G. Rupert Gause, Army Service Forces
Lt. Charles M. Mottley, U.S.N.R., Bureau of Ships
Edward M. Schrock, Aberdeen Proving Ground
Col. Leslie E. Simon, Aberdeen Proving Ground

Friday, December 29, 1944

—9:30 A.M.—

INSECT POPULATION STUDIES

Chairman: John Rice Miner, Mayo Clinic

Field Procedures in Studying Factors Affecting European Corn Borer Populations
William A. Baker, Bureau of Entomology and Plant Quarantine
Population Structure in Drosophila
Theodosius Dobzhansky, Columbia University
Measurement of Urban Rat Populations
John T. Emlen, Jr., Johns Hopkins Hospital

—1:30 P.M.—

NEW APPLICATIONS OF THE SHEWHART CONTROL CHART

Chairman: Colonel Leslie E. Simon, Aberdeen Proving Ground

The Control Chart in Personnel Performance
Richard H. Blythe, Bureau of Forest Service
Control Chart Analysis of Penicillin Assays
Lila F. Knudsen, Food and Drug Administration
An Application of the Control Chart Method to the Testing and Marketing of Foods
Sophie Marcuse, Bureau of Human Nutrition and Home Economics
Analysis of Returns to Determine the Precision of Sample Censuses
W. Edwards Deming, Bureau of the Budget
Janet Jaracz, Bureau of the Census
Discussion: Jerome Cornfield, Bureau of Labor Statistics
Lt. John H. Curtiss, Jr., U.S.N.R., Bureau of Ships
Nathanael H. Engle, University of Washington
Earl E. Houseman, Bureau of Agricultural Economics

MISCELLANEOUS PAPERS IN BIOMETRICS

Chairman: John Rice Miner, Mayo Clinic

Experimental Plans Used in the Southern Co-operative Project
Mary Speirs, University of Georgia
Bryan L. Wade, Regional Vegetable Breeding Laboratory, Charleston
Ralph E. Comstock, University of North Carolina
Some Practical Problems in the Use of Modern Experimental Designs
Otis A. Pope, Bureau of Plant Industry
The Effect of War on Where People Live
Halbert L. Dunn, Bureau of the Census
Some Trials of Incomplete Block Experimental Designs in Insect Population Problems
Francis M. Wadley, Bureau of Entomology and Plant Quarantine

Minutes of the Annual Business Meeting

The American Statistical Association convened for the 104th annual business meeting at 4:00 P.M., Thursday, December 28, 1944, at the Hall of Government, George Washington University, in Washington, D. C. President Helen M. Walker presided. There were 110 members in attendance.

The minutes of the 103rd annual business meeting were approved as published in the JOURNAL.[1]

On motion of Theodore H. Brown it was voted to reject the amendments to Articles V, VI, VII and VIII of the Constitution as proposed at the 103rd annual business meeting of the Association.

The Secretary gave the Annual Report of the Board of Directors.[2]

Willard L. Thorp, Chairman of the Committee on Organization and Structure reported on the activities of his committee and proposed the following amendment to Article XII of the Constitution:

Article XII—Amendments

> The Constitution may be amended either at an Annual Meeting of the Association or by mail ballot. A proposed amendment must be submitted by at least ten members of the Association in writing to the Board of Directors which in turn shall submit it with its recommendation to the members of the Association not less than 60 days prior to the Annual Meeting at which it is to be voted upon or not less than 60 days prior to the date upon which the mail ballot is to be taken. The adoption of a proposed amendment shall require the affirmative vote of two-thirds of the members present and voting at the Annual Meeting at which it is voted upon, or if the amendment is voted upon by mail ballot, of two-thirds of the members whose mail ballots are returned within 30 days after the date of original mailing.

The amendment was passed and, in accordance with the Constitution, will be presented at the next Annual Meeting of the Association.

Walter A. Shewhart reported for the Committee on Publications that Frank A. Ross, Editor of the JOURNAL, has resigned, and Glenn McLaughlin, Review Editor, has said that he would like to be released when a successor can be appointed. The Committee proposed a new editorial structure which was approved by the Board of Directors at its December 27 meeting, according to which there will be an Editor-in-Chief of all American Statistical Association publications, a group of Associate Editors and a group of collaborators. When appointed, the Associate Editors will be asked to prepare a complete statement of editorial policy to be approved by the Board of Directors and presented to the Association.

President Walker announced the appointment of Harold Hotelling to the Committee on Fellows for the period ending in 1949. John Rice Miner, Chairman of the Committee on Fellows, announced the election of the following Fellows: Henry B. Arthur, A. E. Brandt, W. G. Cochran, Gertrude M. Cox, Philip M. Hauser, Frank Lorimer, Isador Lubin, Charles F. Sarle, Alan Treloar, and Sewall Wright.

[1] This JOURNAL (March, 1942) pp. 129–131.
[2] This JOURNAL pp. 111–115.

Stuart A. Rice made a preliminary report for the Committee on the Training of Statisticians.

C. I. Bliss proposed that the following resolution be transmitted to the appropriate Federal officials and committees of Congress:

Resolution on Basic Governmental Statistics

An intimate knowledge of the main characteristics of the economy during the peak of war production will be invaluable as a bench mark for current wartime statistics, as a guide for the development of policies for postwar readjustment and as a part of the record which is essential for military preparedness. In recognition of these facts, the President of the United States has called for the preparation of plans for statistics on industrial production, the distribution of goods and services, and the well-being of the Nation's workers, including the status of employment and wages and the effects of the war on incomes, expenditures and savings.

Therefore, be it resolved that the American Statistical Association heartily supports the efforts of the Federal statistical agencies cooperating with the Bureau of the Budget in planning and making provision for an adequate statistical program for the benefit of business, labor, agriculture and the Government. It is further resolved that the Association hereby endorses this objective of establishing basic government statistics upon a level of completeness and adequacy.

The resolution was passed.

Reporting for the Resolutions Committee (E. G. Plowman and C. I. Bliss) E. Grosvenor Plowman proposed the following resolutions:

1. Whereas, The George Washington University has made available meeting rooms and other facilities for the 104th Annual Meeting of the American Statistical Association,

Therefore, be it resolved that we express our sincere appreciation to the officers of the University for their helpful cooperation.

2. Whereas, the Program Committee has assembled an outstanding group of speakers at short notice, and under difficult conditions,

Therefore, be it resolved that the Association takes this means of thanking the members of the Program Committee and their associates in the Washington Chapter for their effective contribution.

3. Whereas, the Editor of the *Journal of the American Statistical Association*, Frank A. Ross, of Thetford, Vermont, has served the Association in this capacity for thirteen years, from 1926 through 1934 and from 1941 to date, and is now about to retire for health reasons,

Therefore, be it resolved that the members, in Annual Meeting assembled, do hereby express our deep regret at the necessary retirement of Dr. Ross, and tender him this token of our recognition of his valuable services to the Association, so ably performed over a long term of years.

4. Whereas, the Vice-President of the United States of America, the Honorable Henry A. Wallace, has complimented us by his appearance as our guest of honor and speaker at our Annual Dinner,

Therefore, be it resolved that this Association express its great appreciation to the Honorable Henry A. Wallace for his valuable discussion on "The Role of Statistics in Policy Formation."

5. Whereas, during 1944, the American Statistical Association has made substantial progress in membership, in effective organization, and in accomplishments,

Therefore, be it resolved that the Association hereby expresses its appreciation of the untiring efforts of its officers and staff, and the unselfish services of the members of its standing and special committees.

All of the resolutions were unanimously passed.

Morris A. Copeland proposed the following resolution:

> It is the sentiment of this meeting that it would be desirable, if feasible, to hold the next annual meeting of the American Statistical Association at the same time and in the same locality as the American Economic Association, and to arrange one or more joint sessions,
>
> And that the officers of the Association are asked to investigate the possibility of such an arrangement and to take such steps as may seem appropriate to them on the basis of such investigation.

The resolution was passed.

Aryness Joy Wickens proposed to amend Article III of the Constitution which reads: ". . . The number of Fellows shall not exceed one hundred and fifty at any time." to read: "The number of Fellows shall not exceed three hundred at any time." The resolution was passed.

In accordance with the Constitution this amendment will be presented at the next annual meeting.

The following persons were nominated for officers of the American Statistical Association for 1945 by the Nominating Committee as reported by S. S. Wilks, Chairman:

President: WALTER A. SHEWHART, Bell Telephone Laboratories
Vice-Presidents: WILLIAM G. COCHRAN, Iowa State College
A. D. H. KAPLAN, University of Denver
LOWELL J. REED, Johns Hopkins University
Directors: (For the terms expiring at the Annual Meeting in 1947)
CHESTER I. BLISS, Connecticut Agricultural Experiment Station
WILLARD L. THORP, Associated Gas and Electric Corporation
HELEN M. WALKER, Teachers College, Columbia University
Secretary-Treasurer, LESTER S. KELLOGG

The Secretary reported that he had received no nominations by petition. It was voted to instruct the Secretary to cast one ballot for the candidates presented by the Nominating Committee. The ballot was cast and the officers and directors were elected.

The meeting was adjourned.

LESTER S. KELLOGG, *Secretary*

Report of the Board of Directors

The activities of the American Statistical Association in 1944 began to reflect the character of a professional offensive and to indicate that the Association had given up its "holding action." The definite knowledge that the end of the war was in sight, though it couldn't be dated, provided the stimulation that resulted in this greater activity on a number of fronts. The increased urgency for a plan of development for the statistical profession has attracted the interest of the wide resources which are in the membership of the Association. Greater contributions of time and energy of members have resulted, even as members of the profession have been giving in an unprecedented fashion for the war effort.

In 1943, as in 1942, the cancellation of the Annual Meeting made it impossible to follow the customary procedure in electing officers. Using the Constitutional provision for filling vacancies in its own membership as its authority, the Board of Directors at its last meeting in 1943 accepted the resignations of the 1943 officers and of the Directors whose terms would have expired at the Annual Meeting in 1943, and appointed to the vacant positions the candidates proposed by the Nominating Committee.

Immediately after the induction of the new officers the President was requested and authorized to ascertain the opinion of members with respect to the aims and programs of the Association. The answers to Miss Walker's inquiry provided constructive and detailed suggestions for the guidance of the Board; many of these suggestions are proving of great value in the program now being developed.

Annual Meeting 1944. Departing from the policy which led to the elimination of an Annual Meeting in 1942 and 1943, your officers, after long and detailed consideration of the issues involved, decided that the war interests of the United States would be better served by a strong Statistical Association. The Association's Committee planned a number of meetings for the Biometrics Section and for the economic statisticians in cooperation with the Econometric Society at the meetings of the AAAS in Cleveland in September. By mid-year plans were being made for several regional meetings, especially in Chicago and Washington, D. C. Later developments made the Chicago meeting impossible. Developmental needs of the Association's national program appeared more and more to make an Annual Business Meeting imperative. Late in the summer your officers asked the officers of the Washington, D. C., Chapter if they would revise their planned regional program to include meetings of national interest and an Annual Business Meeting of the American Statistical Association. The cooperation of the Washington Chapter and the assignment of national officers to the local Chapter Meeting Committee made possible the meeting that was held. Major among the matters of business was a proposal for revising the Constitution to give it more flexibility, to provide a means by which the membership may have a more direct voice in and responsibility for the Association's affairs, and to

provide for professional development and expansion which is now not possible.

The Biometrics Section. The Biometrics Section met in Cleveland in September in conjunction with the AAAS. At its business meeting new officers were elected and a proposal prepared asking for increased support from the parent Association and permission to publish a small bulletin of its own in 1945. The major activities of the year were directed toward planning its new Biometrics Bulletin.

Publications. During the year Dr. Frank A. Ross, Editor of the Association's JOURNAL, notified the Board that at his doctor's insistence he found it necessary to submit his resignation. He agreed, upon request of the Board, to continue to serve until a successor could be found. The Board's Committee on Association Publication Policy immediately took this additional urgent factor into account and as the year closed presented its report to the President as a basis for action early in 1945.

The Board during the year gave its approval to other publication matters. Early in 1944 the ASA BULLETIN masthead was redesigned and its editorial policy was enlivened. A directory of the members in good standing was approved for 1945 and plans for the accumulation of the necessary factual information were laid. The Board approved the publication of the papers on Public Opinion Polling presented at a two-day joint meeting of the Washington, D. C., Chapter of the American Statistical Association and the Institute of Mathematical Statistics. To be published at cost, these papers will be the first major Chapter publication to be issued by the Association.

Upon a petition prepared by the Biometrics Section at its September business meeting, the Board of Directors approved publication of a Biometrics Bulletin beginning in 1945. This is the first of the Association's sections to develop its own publication since the initiation of the *Annals of Mathematical Statistics* in 1929.

Quarterly issues of the JOURNAL and the BULLETIN were published during the year. Following the precedent set in 1943, the technical appendix to the report of the Committee of the Association on the Cost of Living Index was preprinted and bound with the main body of the report, which was made available for public use before its appearance in the March issue of the JOURNAL.

The Chapters. The activities of the Chapters have continued increasingly to be geared to war needs. The Chapters have taken the responsibility of Association growth seriously and have been instrumental in bringing many new members into the Association. Of special note in this respect is the Los Angeles Chapter. This Chapter was re-established in 1944 and has carried on an active program of meetings and membership.

Chapters have continued to experiment with new programs. The cooperative project of the Chapters of the American Statistical Association and the Institute of Mathematical Statistics mentioned above is one of these, the Chicago Chapter's placement service is another. For the first time, the Na-

tional Office has experimented with one Chapter in the collection of annual dues. Annual dues of fifty cents for the Washington, D. C., Chapter were printed on the Association's annual bills. First reports indicate that the experiment will be successful.

Committees. During the year, President Walker appointed several *Ad hoc* committees to deal with matters of Association program that seemed most urgent. One of these was appointed to re-examine the Association's Chapter program. This committee is to make recommendations with respect to ways in which the Association can more effectively work with Chapters.

A Committee on Classification of Members, after preliminary consideration, decided to forego further work until tabulations of Members' Personal Record forms being collected for the 1945 Members' Directory could be completed.

Committees on Education and Training of Statisticians and on Constitutional Revision and Reorganization were just getting well organized as the year ended.

Curtailment of the activities of some of the Standing Committees continued as a result of war pressures upon their members. The work of some of the committees, however, increased because of these same pressures.

Census Advisory Committee. The Census Advisory Committee met in Washington in April, June, and October for two-day sessions. Major considerations during these meetings were directed to The Census of Agriculture of 1945. Problems of definition and schedule construction in connection with the Census of Agriculture received detailed attention. In April and October sessions were devoted to the current data collection program of the Bureau of the Census and to the President's Reconversion Statistics Program for 1945 including sample studies of income, a sample census of business, and a short-form census of manufactures. The Committee approved two resolutions, one in April and one in October, dealing with the importance of adequate statistical information for use in guiding the reconversion of the war economy to one of peacetime activity.

Committee on Census Enumeration Areas. A questionnaire on uses and needs of census tract information was distributed. Greatly increased correspondence with persons interested in extension of census tracting has been carried on. These activities have been expanded with the aim of: (1) stimulating increased utilization of census tract information when it is available; (2) bringing about re-examination of the areas already laid out in census tracts to include recent expansions as well as entire metropolitan areas; and (3) the extension of plans for census tracts in cities which have not yet developed them.

Other Committees and Representatives. Through its representatives, the Association has continued to participate in the work of the Social Science Research Council, The National Bureau of Economic Research, The American Association for the Advancement of Science, The Advisory Board of the *American Year Book*, and the American Documentation Institute.

At the request of the American Sociological Association, your Secretary served on its exploratory committee on "A Social Statistics Project."

Placement Service. Forced by the necessity of locating every available statistician, the Association has in the past year again engaged in professional placement activities. Early in the year, in a plan designed to assist the Civil Service Commission in locating statisticians for government service, the Association circularized the membership through the BULLETIN. There has subsequently been an almost continuous stream of requests from both government and private agencies for statisticians, as well as requests from members of the Association for placement. The need for the development and continuation of a satisfactory professional placement service must be faced squarely by the Association's membership and officers. This is a service which will require the expenditure of substantial resources.

Membership and Finance. Membership in the Association started to rise again in 1944. During the year there were 456 additions to the membership and 303 withdrawals, leaving a net increase of 153 members and a total membership at the end of the year of more than 3,000. At the current rate of receipt of applications for membership, the total membership is expected to reach 3,500 by the end of 1945. During the year there has been an increase of three in Life Memberships, bringing the total to forty at the year end. There was an increase of seventy in subscriptions in 1944.

Income from membership during the year reflected the changed trend and was slightly more than $100 greater than in 1943. Income from subscriptions likewise reflected the increased effort which has been made to get a wider distribution of the JOURNAL amongst libraries; the great expansion of JOURNAL sales represents part of this same effort to expand the size of library holdings of professional statistical material. Steps are being taken to see that sufficient copies of current and back numbers of the JOURNAL will be in our files to meet the demands of returning service men and of libraries in the rehabilitated areas.

Expenses have also reflected the great expansion in activity. Salaries and wages especially show the effects of increased membership activity, correspondence and work of the Board. Rent, which was nearly $500 greater than in 1943, reflects a full year in rented quarters, as well as an increase in space for part of the year.

December 31, 1944, brought to a close the five-year period of the Centenary Sustaining Fund. In 1939, in the period of the original drive for the Centenary Sustaining Fund, $10,687 was pledged or contributed. As of December 31, 1944, $633.50 remained to be collected. In 1940 and 1941, $4,000 was appropriated by the Board of Directors from this fund for the regular operations of the Association. Since that time the Association has operated out of current income and, except for expenses of the Centenary Sustaining Fund drive, no withdrawals from the fund have been made. As of the end of 1944 there remains $6,114 in the fund. The Board has been extremely pleased that the Association has been able to increase its rate of

operations without impairing its funds, and looks forward to the time when the Centenary Sustaining Fund and its surplus, may be available to support an expanded program.

As the Association moves into 1945 on a rising trend of activity and professional growth, your officers believe that the Association is soon to face some of the knottiest and most important problems it has had since its birth. The return of American industries to the production of their peacetime products must be accompanied by a solid background of guiding statistics. The benefits gained by statistics during the war period must not be lost for peacetime industry. The new fields of subject matter to which statistics may be adapted must not be permitted to go uncultivated. To gain these ends, the Association must continue to move and to move rapidly along the paths which are currently being charted.

HENRY B. ARTHUR	SIMON KUZNETS
C. I. BLISS	E. GROSVENOR PLOWMAN
THEODORE H. BROWN	WALTER A. SHEWHART
LESTER S. KELLOGG	HELEN M. WALKER

Report of the Secretary

During 1944 the total membership of the Association increased from 2,883 to 3,036, a net gain of 153 members. During the year, 435 new members were elected and 21 former members were reinstated. Eighty-six members resigned; 202 members were removed from the active rolls for failure to pay dues; and 15 members were lost by death during the year, including two Fellows. By the end of the year, 215 members had reported to the Association that they were privates or non-commissioned officers in military service, and at least 130 members were commissioned officers.

The death of the following members was recorded during the year: Arne Fisher, *Fellow;* Henry L. Rietz, *Fellow and Senior Member;* Charles T. Main, *Senior Member;* S. T. Armstrong and Park H. Sercombe, *Life Members;* John B. Andrews, Paul Barnett, M. F. Fuller, Henry Albert Handrick, Sylvester Schattschneider, Emanuel Streisand, William A. Sturm, Raymond R. Willoughby, Emma A. Winslow and Harry J. Winslow, *Regular Members.*

Membership Statement, December 31, 1944

Honorary members	15
Corporate members	4
Fellows	126
Regular members	2,891
Total membership	3,036

Three new Life Members, Paul T. Babson, Sarah R. Krupp and Roy R. Newberger, were elected during the year, bringing the number of life members to 40 (two having died during the year).

LESTER S. KELLOGG, *Secretary*

Report of the Treasurer

The Association's income in 1944 from regular sources was $20,872, the largest in its history, and an increase of $2,500 over 1943. Nearly $1,000 of the increase was due to increased sales of the JOURNAL; there were substantial increases in subscriptions ($557) and in advertising ($293). Income from membership dues started up again with an increase of $127 over 1943.

In line with increased activities, as described in the *Report of the Board of Directors*, expenses in 1944 totalled $21,146, an increase of $3,872 over 1943, resulting in an excess of expenses over income in 1944 of $274. Increased salaries, rent, travel and office expenses largely account for the increase over 1943. Reduced to a long-term low point in personnel in 1943, increased activities in the last 9 months of 1944 required the addition of the considerable part-time assistance. The increase in rent represented a full year in rented quarters against 7 months in slightly smaller quarters in 1943. In 1942 and the first 5 months of 1943 the Association enjoyed rent-free space at the American University. Expanded Board and Committee activity led to increased travel, printing, postage and communications. The BULLETIN was expanded again at an increase in cost of about $300. Activities of the Biometrics Section and preliminary expenses for the *1945 Membership Directory* added to total expense by almost $200.

The addition of an addressograph machine to the Association's equipment increased the depreciation expense but provided a very valuable resource in these times of expensive and slow schedules by servicing agencies.

The end of 1944 brought to a close the period of collection of the Centenary Sustaining Fund. A total of $10,687 was pledged to the fund in 1939 to be paid in the 5-year period beginning January 1, 1940; of this total $10,053 had been paid by the end of the year, leaving $633 to be collected. Appropriations were made from this fund for the Association's operations by the Board of Directors in 1940 and 1941 of $1,500 and $2,500 respectively. Deducting these amounts and the expenses of the fund campaign there remains in the fund $6,114 for the Association's future programs. To the greatest possible extent the Board is currently trying to expand current income to meet increasing current expense without materially tapping its reserves.

The balance sheet and other detailed financial statements with comparisons for 1943, are included in the Report of the Auditors.

LESTER S. KELLOGG, *Treasurer*

Report of the Auditors

To the Board of Directors of
American Statistical Association

We have examined the balance sheet of American Statistical Association as of December 31, 1944 and the statements of income and surplus for the year then ended. Our examination was made in accordance with generally accepted auditing standards applicable in the circumstances, and included such tests of the accounting records and other supporting evidence and such other procedures as we considered necessary.

The recorded cash receipts for the year were traced to the deposits shown on the bank statements and the amounts for dues and subscriptions were tested with the membership and subscription records. The paid checks and relative vouchers were inspected in support of the cash disbursements for the year. The bank balances were reconciled with certificates obtained direct from the depositaries and the cash on hand and the securities owned at December 31, 1944 were verified by inspection. We did not check the membership and subscription records in detail or make any independent verification of the inventory of old journals, the office records of which are based in part on data assembled in prior years, no recent physical inventory having been taken.

The life membership reserve is computed on the basis of the combined annuity table of mortality with assumed interest at 4% per annum and an assumed annuity of $5.00 per life member, in accordance with a resolution of the Board of Directors on March 31, 1936. The amount treated as income in each year represents the excess of the reserve at the beginning of the year plus interest for the year and new life membership receipts over the required reserve at the end of the year.

In our opinion, the accompanying balance sheet and related statements of income and surplus present fairly the position of American Statistical Association at December 31, 1944 and the results of its operations for the year, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

PRICE, WATERHOUSE & CO.

Washington, D. C.
March 13, 1945

AMERICAN STATISTICAL ASSOCIATION

BALANCE SHEET

Assets	December, 31 1944	1943
Cash in bank and on hand	$10,178.04	$ 7,599.72
Accounts receivable	289.53	542.85
Investments:		
United States Savings Bonds, Series D, at redemption value	5,615.00	5,481.00
Stocks, at cost, (at market quotations $5,160 and $4,460, respectively)	5,793.50	5,793.50
Inventory of old JOURNALS, at approximate cost	1,683.32	1,668.70
Furniture and equipment, at cost less depreciation	716.52	417.04
	$24,275.91	$21,502.81
Liabilities		
Accounts payable	$ 1,247.16	$ 1,345.65
Centenary Sustaining Fund, per statement	6,114.21	5,670.81
Life membership reserve	2,614.83	2,455.68
Deferred credits (collections applicable to subsequent year):		
Dues	5,295.72	3,533.07
Subscriptions	2,711.57	2,097.50
JOURNAL advertising	176.40	
Surplus, per statement	6,116.02	6,400.10
	$24,275.91	$21,502.81

AMERICAN STATISTICAL ASSOCIATION

INCOME STATEMENT

	Year ending December 31, 1944	1943
INCOME:		
Dues—current year	$12,902.75	$12,775.00
Dues—prior years	47.75	130.50
Life memberships	239.08	179.51
Subscriptions	3,909.00	3,352.50
Advertising	949.59	656.83
Reprints	974.79	617.48
JOURNAL sales	1,267.35	306.65
Index to the JOURNAL, sales	10.00	12.00
Special publications	56.33	46.97
Annual Meeting ($1,686 registration fees less $1,363.14 expenses)	322.86	
Miscellaneous	12.50	67.75
Dividends and interest (after deducting $98.23 in 1944 and $93.66 in 1943 apportioned to life membership reserve)	179.72	197.42
	$20,871.72	$18,342.61
EXPENSES:		
JOURNAL—printing, mailing and reprints	$ 5,068.63	$ 4,685.56
BULLETIN	672.51	381.79
Salaries and wages	11,489.62	9,699.14
Unemployment compensation tax	10.96	110.60
Rent	834.00	372.17
Office supplies, printing and mimeographing	680.66	646.81
General postage and carriage	678.65	435.62
Telephone and telegraph	296.41	188.31
Travel expense—officers	523.11	253.85
Biometrics Section expenses	91.93	
Directory expense	85.00	
Storage of old JOURNALS	72.00	72.00
Cost of old JOURNALS sold	154.88	26.88
Depreciation of furniture and equipment	126.44	73.60
Miscellaneous expense	361.00	295.88
	$21,145.80	$17,242.21
Balance carried to surplus	$ (274.08)	$ 1,100.40

AMERICAN STATISTICAL ASSOCIATION

SURPLUS STATEMENT

	Year ending December 31, 1944	1943
Balance at beginning of year	$ 6,400.10	$ 5,311.70
Add—Excess of income over expenses for the year, per income statement		1,100.40
	$ 6,400.10	$ 6,412.10
Deduct—Excess of expenses over income for the year, per income statement	$ 274.08	
Appropriation to Centenary Sustaining Fund of amount equal to net proceeds from sales of Index to the JOURNAL	10.00	$ 12.00
	$ 284.08	$ 12.00
Balance at end of year	$ 6,116.02	$ 6,400.10

STATEMENT OF CENTENARY SUSTAINING FUND

	Total	Year ending December 31, 1944	Prior to 1944
Contributions and pledges (relating to the support of the activities of the Association for a period of five years from January 1, 1940 to December 31, 1944)	$10,687.02		
Less—Pledges not collected at December 31, 1944	633.50		
Amounts received from contributors	$10,053.52	$327.50	$ 9,726.02
Interest received on bank savings account and increase in redemption value of securities	437.07	105.90	331.17
Appropriation from surplus of amount equal to net proceeds from sales of Index to the JOURNAL	400.15	10.00	390.15
Total receipts	$10,890.74	$443.40	$10,447.34
Less—Expenses of campaign (printing, postage and temporary assistance)	776.53		776.53
Net receipts	$10,114.21	$443.40	$ 9,670.81
Appropriations by the Board of Directors to the general account of the Association in accordance with the budget:			
Year 1940 $1,500.00			
Year 1941 2,500.00	4,000.00		
Balance December 31, 1944, per balance sheet	$ 6,114.21		

List of Committees and Representatives for 1944

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Theodore H. Brown
Lowell J. Reed
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Aryness Joy Wickens

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BOOK REVIEWS

GLENN E. MCLAUGHLIN
Review Editor

Production of Industrial Materials in World Wars I and II, by Geoffrey H. Moore. New York: National Bureau of Economic Research. 1944. 81 pp. 50 cents.

The magnitude of real income and production which we have attained during the war is a question of major importance at present because it provides a frame of reference for measuring the magnitude of the postwar problem of full employment. Most workers in the field are agreed that production and real income have increased phenomenally during World War II. The Department of Commerce estimates that the gross national product, as measured in 1939 dollars, has risen from $88.6 billion in 1939 to $155.3 billion in 1943. The Federal Reserve Board estimates that the index of industrial production has risen from 109 in 1939 to 239 in 1943. Both series indicate that a large portion of the rise has occurred since 1941.

The author of this Occasional Paper, if I interpret him correctly, is inclined to the belief that the increase in industrial production during this war has not been substantially greater than it was during the last war, or about 35 per cent. What is even more significant, he apparently believes that we may not have had any significant increase in production since the middle of 1941, six months before our entry into the war.

Mr. Moore has constructed an index of production of 47 industrial materials. Comparing the behavior of this index during the two wars, he finds that the total output of industrial materials has risen about 35 per cent during the first three years of World War II as compared to 32 per cent in the corresponding period of World War I. (Mr. Moore concedes that his index is biased downwards because it is based on a list of identical materials in the two wars, thereby excluding the expansion in production of such items as synthetic rubber, nylon, and plastics. He does not attach significance to this point, however, in his summary.) He finds further that in both wars the increase in output of industrial materials ceased before we entered into the war. In World War I, production leveled off in December 1915, 16 months before our entry, and in World War II expansion ceased in June 1941, 6 months prior to our entrance.

In peacetime there is a close correspondence between changes in output of industrial materials and changes in industrial production. Mr. Moore seems inclined to believe, therefore, that this relationship may also have held during the war. True, he does not make this statement explicitly. He writes only that:

> It is not easy to say how close this relationship is in wartime because of the difficulty of measuring total output. Hence it is uncertain in what degree our conclusions concerning the production of industrial materials apply also to total industrial production. (p. 1)

Nevertheless, the implication that total industrial production may not have increased to a substantially greater degree than did the production of industrial materials is quite clear.

Thus after examining the available data on total industrial production, production of industrial materials, and manhours Mr. Moore concludes:

> It seems that all we can say with certainty concerning total industrial production between 1940 and 1942 is that the increase in input of labor, measured in manhours, greatly exceeded the increase in input of materials. (p. 46)

The author does not believe we can say with certainty that total industrial production also increased substantially more than did the input of materials. This quotation refers only to 1940–42, but the data for most of 1943 were available prior to publication of this book, and the author suggests on several occasions that they do not call for significant changes in his conclusions.

Even more significant is the author's analysis of the Federal Reserve index of industrial production. Mr. Moore points out that that index, which rises to 190 in July 1943 (1939 = 100), differs from his own which remains essentially at the 1941 level of 135, chiefly because it includes the "manhours series" to measure output in the transportation equipment and machinery industries. (Mr. Moore is here dealing with the unrevised Federal Reserve index; the revised index stood at 240 instead of 190 in July 1943.) He then argues that because of the non-homogeneity of war products and their non-comparability with peacetime products it is difficult to determine whether the increase in manhours in these industries represents decreased productivity per manhour or increased product. This is caution carried to the point of recklessness. Total manhours in these industries increased 60 per cent between 1941 and 1942 and an additional 35 per cent between 1942 and 1943, or a total of 115 per cent between 1941 and 1943! And while there is little evidence on the trend in productivity in these industries, what little there is indicates a phenomenal increase during this period. Thus the manhours required per Liberty ship delivered were cut more than half between December 1941 and the middle of 1943, while the average weight of airframe accepted per employee more than doubled between the end of 1941 and the beginning of 1943. In the face of such data, does the author really believe that total output in these industries did not rise substantially during this period?

Mr. Moore's major conclusion is that

> It seems best to abandon any attempt to measure total industrial production, for the fact of conversion lends an element of arbitrariness, unreality, and uncertainty to any index that purports to measure the total. (p. 49)

> The statistical difficulties may be largely avoided if we concentrate upon the materials used in industry rather than the final products. . . . Indeed the measurement of the input of materials is one approach to the knotty theoretical problem involved in measuring changes in total output when its composition is radically altered, as it is during a war. (pp. 2–3)

It is true, of course, that the Federal Reserve index may overstate the actual increase in industrial production since 1941. That there has been a

very substantial increase, however, is hardly open to question. To replace an index which may have risen somewhat too rapidly by one of its components which leveled off 6 months before we entered into the war cannot be considered a satisfactory solution. Between 1941 and 1943 the Federal Reserve index rose 48 per cent, manhours in mining and manufacturing rose more than 40 per cent, while the index of industrial materials remained practically unchanged. If Mr. Moore thinks the Federal Reserve index must be replaced, why should the replacement be an index of industrial materials rather than an index of industrial manhours?

JACOB L. MOSAK

Washington, D. C.

Price Making in a Democracy, by Edwin G. Nourse. Washington: The Brookings Institution. 1944. x, 541 pp. $3.50.

Dr. Nourse of the Brookings Institution has for about a decade been conducting a dignified, but nonetheless determined crusade in the business and economic world.

His basic theory is simply that big business men should adopt policies of reducing prices as improvements in technology lower their unit costs of production. This, of course, is an objective with which most economists are in undoubted agreement. In fact, many will go one step further and state that businesses ought to reduce prices, even though no technological advance has occurred, in the hope that such lowered prices will expand sales and output and thereby reduce unit costs.

In developing his thesis, however, Dr. Nourse advances a number of contentions with which there is considerable room for disagreement. Foremost among these is the argument that large corporations are essentially the inevitable product of greater economies of large producing units. This assumed relationship between plant-size and the huge corporate enterprises of the country is, at best, extremely tenuous, and is nowhere examined by Dr. Nourse, although there does exist a considerable volume of factual data bearing on the subject.

Another omission is his failure to discuss some of the new and prospective technological developments which may well reduce drastically the optimum plant size in a number of important industries. There is strong evidence that in many fields the technology of today is moving in the direction of greatest efficiency in smaller plants.

But the element in his argument which will probably arouse the greatest opposition is his tendency to deprecate the force of competition. There can be little doubt but that competition has frequently proved to be a tremendous force in bringing about reductions in prices, improvements in quality, and general economic well-being. But competition must have a healthy environment if it is to achieve these results. Such an environment was by no means universally prevalent during the 20's, when the anti-trust laws were

practically shelved and mergers were allowed to take place on a gigantic scale. Similarly, the environment was not too favorable during the 30's when it became almost impossible, because of institutional developments in the financial system, for most small and many medium-size businesses to obtain venture capital and long-term and intermediate-term credit.

Even so, there did exist certain segments of the economy in which truly competitive conditions prevailed during the past two decades. A long-term examination of a number of such industries revealed that decreases in their unit labor requirements were closely paralleled by reductions in their prices. On the other hand, a similar examination of a number of highly concentrated industries possessing administrative control over their prices, disclosed that reductions in unit labor requirements were accompanied by a relative stability of price. (TNEC Monograph No. 22, Pt. II, *Technology and Economic Balance*, by John M. Blair.)

If we are to learn from the past, there is thus reason to believe that in the concentrated industries comparatively little use will be made of price reductions as a means of expanding output as technological progress occurs, whereas in the competitive industries price reductions will tend to parallel technological advances.

Dr. Nourse, however, is relying not so much upon the record of the past as upon a hope for the future. In expressing this hope he is at pains to point out many of the obstacles which stand in the way of any widespread adoption of low-price policies by firms in a monopolistic or oligopolistic position. In addition to the inherent tendency to maximize gains in the short-run period, Dr. Nourse discusses, specifically, such impediments to price reductions as high distributive costs. Why should manufacturers attempt to broaden their markets by lowering their prices, if such reductions are to be merely absorbed in whole or in part by wholesalers and retailers? Dr. Nourse answers his own question only by advancing the belief that distribution is becoming and will become more efficient.

Advertising is also seen as a formidable barrier. But here Dr. Nourse stresses primarily the expense of advertising. Actually it has a deeper significance. It is through advertising that price lines are established and maintained, the existence of which militates greatly against the occurrence of price reductions.

Similarly, it is through advertising that attention is focussed on quality factors rather than on prices. Quality improvements, from an economic point of view, are not always equal in importance to reductions in price. For example, no matter how many quality improvements might have been added to the early refrigerators, the industry would never have obtained a mass market—with its resultant contribution to economic activity—had prices not been reduced to levels within the reach of the middle and lower-middle income groups.

Dr. Nourse also regards assumptions held by many business men concerning the elasticity of demand as a serious impediment to price reductions. He

feels that the methods employed in this field by statisticians suffer from important weaknesses, which often have the unfortunate effect of strengthening the business man's assumptions. He raises questions "first as to the validity of the idea of a composite elasticity, and second, as to the applicability of the elasticity measurement to the price-making problems of the industrial market."

Then there is the further problem of the necessity for price reductions to be simultaneous and concerted among products for which there exists a joint demand. Dr. Nourse raises the interesting question of whether or not concerted price-lowering action by producers of complementary products designed to "promote" trade would run afoul of the anti-trust laws.

With respect to the timing of the price reductions, Dr. Nourse does not believe that they should be made during the downswing of the business cycle, holding that such cyclical price flexibility tends to aggravate deflationary tendencies. Rather, it is his belief that such reductions should be made during times of prosperity. He recognizes, however, that this appears to be against the natural tendencies of business men, and states that, "We could expect the holder of a 'charge what the traffic will bear philosophy' to *advance* prices at a time of easy sales as far as he could without unduly curtailing volume of sales." If price reductions should not be made in depressions and will probably not be made in prosperity, the question then arises as to when they are to take place.

There are, of course, additional barriers to the adoption of low-price policies by big business, some of which, such as financial controls, are not discussed in this volume. And there are others which he touches on only briefly, as in the case of this sardonic comment concerning certain hired economists of business concerns.

> These technicians shrewdly conclude that their record is going to look best if it shows a high number of instances in which they warned the company against impending danger of an unprofitable venture and kept them from "sticking their necks out." Since restrictive policies by many individual firms culminate eventually in a general business recession, this system is bound to "pay off" and the counsellor of the individual firm cannot be held responsible for a general condition.

To most of the problems which he raises, Dr. Nourse advances solutions, some of which seem quite reasonable, but most of which appear to this reviewer to be largely the product of wishful thinking. It would certainly seem to require faith of a very high order to believe that large corporations in monopolistic or oligopolistic positions actually will adopt, on their own volition, the low-price policies set forth in this book.

As long, however, as Dr. Nourse regards his program as complementary to, and not as a substitute for, measures to intensify competitive activity, his efforts can do no harm and might possibly do a great deal of good. He certainly should not be deterred from his work by those who, perhaps, do not have the vision to see that the leopard might actually change his spots.

Washington, D. C. JOHN M. BLAIR

Curbing Inflation Through Taxation, by Marriner S. Eccles, Alvin H. Hansen, et al. New York: Tax Institute, Inc. 1944. ix, 261 pp. $2.50.

Professor Mabel Newcomer, in the foreword to this symposium, says: "The war on inflation has yet to be won." She apparently felt the need for emphasizing that the topic of the symposium was still timely in February 1944 when many people believed that with the leveling-off of war expenditures the adoption of additional anti-inflationary tax devices for fighting inflation was no longer necessary.

First of all, it is true that *potential* inflationary as well as deflationary dangers extend into the period of declining war expenditures and the beginning of reconversion. Alvin Hansen presents a well-balanced analysis of the inflationary (and deflationary) potentialities of the public debt. James Hughes predicts that the expansion of the public debt "will have the conventional unexpected ending in some kind of catastrophe." It is significant that he attributes the unexpected (but expected by him) inflationary catastrophe to political rather than economic factors.

Marriner Eccles warns against overoptimism with respect to the curtailment of taxes in the postwar period. He questions the assertion that a drastic reduction in business taxes by itself assures high capital expenditures by business. This warning appears very necessary in view of the fact that so much of the current discussion of this subject is based on assertion rather than on analysis.

Most of the papers in the volume deal with problems of wartime inflation and wartime tax policy. But even these papers have by no means lost their actuality. A critical appraisal of the use (or non-use) of taxation in the fight against wartime inflation is extremely important in planning tax policy for the transition and postwar period. Of particular interest is Milton Gilbert's analysis of the reasons why many economists have overestimated the expected inflationary pressure. He gives two main explanations, first, that the productive capacity of the country has been underestimated and, second, that the wartime propensity to save has been underestimated. Most economists expected a "spill-over" of demand from unavailable durable goods to available nondurable goods and services, while in reality consumers as a whole have saved the portion of disposable income which presumably would have been used for purchase of durable goods if they had been available.

The chapters dealing with the various special anti-inflationary tax devices help to answer the question of why these devices, such as general sales taxes, spendings tax, compulsory savings, and increase in social security contributions, have not been used. The only devices actually used are specific excise taxes and the individual income tax collected at the source. Not discussed is the role of corporate taxes and of state and local taxes in the fight against wartime inflation. I also feel that a discussion of the interrelationship between fiscal and other controls is missing. It is not possible to form an opinion concerning the adequacy or inadequacy of tax measures unless it is

ascertained to what extent the failure to use the tax device more fully has rendered direct controls more difficult.

The survey of experiences of other countries adds to the usefulness of the volume.

GERHARD COLM

U. S. Bureau of the Budget

International Currency Experience, Lessons of the Inter-War Period, League of Nations. New York: Columbia University Press. 1944. 249 pp. $3.25.

This book, the work principally of Mr. Ragnar Nurkse, is perhaps the best available study of international monetary developments during the inter-war period. Written with a keen awareness of the significant analytical and policy aspects, the work treats successively over-all monetary demand-supply conditions, exchange standards, central bank policy and practice, exchange fluctuations, stabilization funds, exchange control, and underlying non-monetary conditions. The chapters on central banks, exchange fluctuations, and exchange control probably will have the greatest appeal to most readers. Although one may raise objections with respect to details here and there, these chapters focus effectively on the broad balance of payments, business cycle, and international welfare aspects of the subjects considered and offer numerous keen insights even to the specialist. The chapter on stabilization funds is a useful summary of the experience of many countries, but lacks the penetrating analysis that may be found in other studies. American readers should supplement this chapter with Dr. Bloomfield's excellent paper on the American Stabilization Fund, which appears in the *Review of Economic Statistics* of May 1944.

Two points deserve specific mention. For the first time in print there is a much-needed debunking of the notion of *the* equilibrium rate of exchange. All this time the simple fact has been overlooked, despite the general Keynesian emphasis during the past decade, that at different levels of income and employment balance-of-payments equilibrium can be achieved at different rates of exchange. After this point is made, however, there is repeated reference throughout the book to the equilibrium rate in an unqualified sense. In the second place, the commercial policy section contains a very misleading twofold classification of discrimination, by commodities and by countries. Surely one misses the point of the discrimination controversy by treating the commodity or purely internal type as of coordinate importance, since that type, in common with numerous forms of differential economic treatment outside the field of international trade, is instituted by the very country "discriminated" against. Internal discrimination is best left out of a brief and incidental analysis of commercial policy, as it only serves to distract attention from the really troublesome category—international or country discrimination in its numerous and ever-changing forms. For the sake of decent international relations and the welfare of small states, the

United States must be especially vigilant against international discrimination.

The statistical appendix contains material in compact form concerning world gold supply, and central bank assets and reserves on a country basis.

VIRGIL SALERA

Foreign Economic Administration

World Commodities and World Currency, by Benjamin Graham. New York: McGraw-Hill Book Company, Inc. 1944. xii, 182 pp. $2.00.

In his book, *Storage and Stability*, published in 1937, Mr. Benjamin Graham proposed a national currency which would be issued freely for and redeemable in a composite unit of primary commodities. In spite of the fact that the plan received favorable comment from a number of competent economists (for a list see page 110 of the book under review) the plan has not been widely studied.

In his new book, *World Commodities and World Currency*, Mr. Graham has shifted the emphasis from the national and monetary aspects to the international and commodity aspects of his fundamental money-commodity relationship. He proposes that an international organization buy at 95, without limit, and sell at 105, a composite commodity unit. Such purchases are to be financed ultimately by advances of the central banks of the various nations. (In spite of the title, no world currency is proposed.) It is in essence, therefore, a scheme for international buffer stocks with the objective of mitigating the business cycle. It offers specific solutions for the two most difficult problems of such buffer stocks—the administration of purchase and sale and the method of financing.

It is to be hoped that this idea of the use of a buffer stock of composite commodity units will be adequately analyzed by economists interested in the control of primary commodities and of the business cycle. It is possible that it is politically more feasible than the earlier plan which called for a radical revision in our monetary system. To the reviewer either the older or the newer variant seems a more fruitful method of attack upon the cyclical fluctuations of prices and trade than the devices of timed public works or deficit spending by government, which are more widely advocated.

The analysis of the plan furnished by the volume under review is quite general. The economist is advised to begin the book at Chapter V, which presents the plan. The earlier chapters are largely an attempt to link the plan with other movements which already have followings; they will seem superficial and sometimes faulty to such a reader. Subsequent chapters, particularly Chapter X, are more rewarding. The references in the Chapter Notes and the Appendixes will be of help to those who desire to obtain the comment of others upon a commodity reserve currency.

PRENTICE N. DEAN

United States Tariff Commission

Effect of Federal Taxes on Growing Enterprises, Study No. 2, Polaroid Corporation, by J. Keith Butters and John Lintner. Boston: Harvard University, Graduate School of Business Administration, Division of Research. 1944. v, 63 pp. 50 cents.

This valuable case study briefly reviews the remarkable development of Polaroid, discusses its postwar prospects, and projects its probable financial needs and resources. The authors estimate that, in the absence of special excess profits tax relief, working capital available from internal sources will fall considerably short of requirements, assuming a 40 per cent tax rate. They then discuss refunds and adjustments of wartime corporate taxes and the relation of the Federal corporate tax to postwar expansion of Polaroid.

The study highlights the desirability of speeding up refunds of income and excess profits taxes due to carrybacks during reconversion, and recommends legislation for this purpose. The authors advance no recommendations for long-term tax policy on the basis of the Polaroid case, and it is to be hoped that readers will share their caution. The hasty reader might suppose that deficiencies of working capital from internal sources faced by Polaroid are attributable entirely to the corporate income tax, yet this is not the case. Disregarding carryback refunds, complete abolition of the tax would supply only about half the estimated average deficiency in the first three postwar years.

Polaroid's expected situation would ordinarily call for flotation of new equity securities. Butters and Lintner believe that stock could be sold on favorable terms but fear that management "may not want new capital badly enough to incur the cost of acquiring it." That "cost," they admit, would not be primarily financial loss to present stockholders but possible weakening of management control. If Polaroid does not secure necessary capital, it seems to me that the responsibility will rest less with the tax system than with refusal of management to take advantage of the unique opportunities of the corporate form.

The authors conclude that a high corporate tax after the war would repress rapidly growing firms. It should be remembered, however, that, according to this study, Polaroid would be helped only by reduction or elimination of the tax on retained profits. Most proposals, even for "abolition" of the corporate tax, include a tax on retained profits to reduce tax avoidance by individuals. Moreover, as the authors recognize, before passing final judgment on the corporate income tax, the effects of this tax must be compared with alternative sources of revenue and with deficit financing and reduction of Federal expenditures.

RICHARD GOODE

U. S. Bureau of the Budget

State Taxation of Metallic Deposits, by Warren A. Roberts. Cambridge: Harvard University Press. 1944. xiv, 400 pp. $4.50.

In this book the author presents a series of case studies in public finance which are at the same time case studies in "political equilibrium." The mine-

tax legislation and administration of thirteen mining states are reviewed against a background of political conflict over the economic rent of the mines. Generally, this was a conflict which found the mine owners and operators ranged against farmers and laborers, and in which the interests of the state at large were opposed to those of the counties in which the mineral deposits happened to be located. The author devotes considerable attention to analyzing the types of pressures available to those engaged in this conflict and to the broad pattern of the contest itself. In so doing he has made a substantial contribution to an understanding of the wide differences in state mine-tax laws.

The amount of attention given to each state varies widely with the importance of its mineral deposits and with the intensity of the political activity generated by the issue of mine taxation. Thus Arizona and Minnesota, where the mines have been extremely productive and where the contest over their economic rent has brought to the fore striking personalities, are between them accorded 139 pages. On the other hand, but 11 pages are given to the states of South Dakota, Louisiana, and Arkansas. The other states covered in this study are Nevada, Utah, Idaho, Montana, Colorado, New Mexico, Alabama, and Michigan.

The basic thesis of the study is that the value of these mineral deposits "sprang from a national demand, and that the accident of their location provided a problem in politics as well as in public finance." The lack of uniformity in mine-tax legislation is explained in terms of the different political and economic conditions in the several states, and the different political pressures that were consequently generated. The revenue laws of each of these states, it is pointed out, had to hold in equilibrium unusually hostile political forces. To that end, they had not only to balance the community desire for equity with its desire for uniformity, but they had to reconcile pressure groups with widely differing conceptions of equity.

Although five of the states, including most of those with iron and copper deposits, found the solution of the mine-tax problem in the property tax, the author is critical of this levy in its application to such ore deposits. He also finds serious weaknesses in the administration of mine taxes whether of the ad valorem type, or of the type which is based on some combination of gross and net income. These, he believes, can be cured "only by legislative direction, by appointment of able personnel, and by the clarification of terminology."

E. GORDON KEITH

Washington, D. C.

Industrial Life Insurance in the United States, by Malvin E. Davis. New York: McGraw-Hill Book Company, Inc. 1944. xii, 399 pp. $2.75.

This latest volume in the McGraw-Hill Insurance Series edited by Ralph H. Blanchard of Columbia University is a welcome addition to the literature

of insurance. The author, Associate Actuary, Metropolitan Life Insurance Company, brings to his subject a familiarity with the industrial branch of the business, which he has supplemented by consultation with specialists in various phases of industrial insurance practice.

Industrial life insurance is sold in units of less than $1000, and premiums, which are payable weekly (sometimes monthly), are usually received by the agent at the home of the policy holder. Although industrial insurance serves far more people than "ordinary," which is sold in units of $1000 or more with premiums payable annually, semi-annually or quarterly, treatises on life insurance principles and practices have dealt almost exclusively with the ordinary form. The same actuarial principles apply in both branches of the business but in its mechanics the industrial form varies considerably from the ordinary.

Because of the problems which it involves, many life insurance companies have not entered the industrial field. Some of those that have done so have emphasized combination life, health, and accident insurance in which the life insurance element is secondary. About three-fourths of the industrial insurance in force in the United States is in the three largest American companies among which the author's own company is included. The discussion of company practices, according to the author, is based upon those of his company but the more important deviations by other companies are noted.

In the six parts into which the book is divided the author discusses the origin and development of industrial life insurance, the policy contract, agency and home office organization and operation, cost factors, actuarial factors, and the effectiveness of industrial life insurance in serving the purposes for which it is designed. Some 50 pages of appendices add considerable value to the book, both from the standpoint of classroom use and its use as a reference for professional life insurance people.

J. Edward Hedges

Washington, D. C.

The Production Credit System for Farmers, by Earl L. Butz. Washington: The Brookings Institution. 1944. vii, 104 pp. $1.00.

In this new Brookings study, Dr. Butz presents an able review and analysis of the Production Credit system during the ten years since its establishment in 1933. The Brookings Institution is to be congratulated not only for continuing the series on short term credit started in 1926 of which this volume is the fourth, but also for providing this study at a most opportune time when Congress is giving special attention to ways of simplifying the structure of Federally sponsored agricultural credit agencies.

The first half of the book is devoted to facts and figures while the last half is mainly given over to the pros and cons of the Government subsidy in the Production Credit System.

On the question of subsidy, a recent storm center of controversy, Dr.

Butz suggests a more rapid retirement of government capital in the associations. To accomplish this he advocates a policy of allowing associations to discount up to seven times their unimpaired capital and surplus, and placing added pressure for income on those associations which are not self-sufficient.

The small loan, one of the most difficult problems facing the Production Credit System, presents a dilemma which Dr. Butz recognizes but does not entirely resolve. As long as Congress specifies a low uniform interest rate throughout the country, associations making small loans will find it difficult to live on their income. Increased fees and charges and increased efficiency are recommended as partial solutions but the author points out that some associations may never reach a self-sufficient status.

Some students of the subject may find too much attention given in this book to the subsidy question and too little to such questions as the kinds of loan service provided in different areas of the country, the amount of reserves needed to weather a severe depression, reference to other studies of the System such as the one by Galbraith and Black, and possible economies through more cooperation between production credit and national farm loan associations. This is undoubtedly a valid criticism but a satisfactory treatment of these and other phases would probably have required much more time and effort than was available. All will agree, however, that this volume does not exhaust the subject.

On the whole, Dr. Butz has given us an excellent study of the Production Credit System. The organization of the book, especially the subheadings and summaries, makes it easy to use as a reference. With the assistance of Production Credit officials, new and useful statistical data on the operation of the System are provided. Finally, the discussion of policy questions is straightforward and well balanced.

WILLIAM G. MURRAY

Iowa State College

The Socialist Movement in Reading, Pennsylvania, 1896–1936, by Henry G. Stetler. Storrs, Connecticut: Stetler. 1943. vii, 197 pp. $2.00.

This Ph.D. dissertation constitutes the first serious attempt in America to analyze the national, social, and economic backgrounds of voters in an American city where the socialist movement has succeeded in controlling the city administration. For years many critics of socialism have charged that the socialist movement was made up largely of aliens on the lowest rungs of the economic ladder, and that socialists could not expect to elect to office any considerable body of men and women except from these social groups.

Dr. Stetler, in his monograph, subjects these charges, among others, to a thorough-going, scientific analysis as applied to one of the three cities in this country with a population of over 100,000 in which, during the last twenty-five years, socialists have been in power—Reading, Pennsylvania.

His discoveries are of public interest and fail to bear out the charges so frequently made. Among the facts disclosed are the following:

(1) In 1930, of the 111,000 population in Reading, 89.6 per cent were native white, as contrasted with 77.8 per cent in the United States as a whole, and 71.8 per cent were native white of native parentage, as contrasted with a national percentage of 57.1 per cent. Only about 11 per cent of the persons in Reading were of German origin and "socialists were consistently supported irrespective of nativity lines."

(2) The mass voting support for socialist candidates came consistently from the home-owning class—probably small home-owners of which Reading has an unusually large percentage. (Sixty per cent of Reading's families owned their homes, this percentage being equalled by only three United States cities having more than 100,000 population.)

(3) Socialists drew their strength chiefly from the skilled and semi-skilled working class, the overwhelming proportion of candidates for office coming from the skilled trades.

(4) The vote for socialist candidates seemed to bear little relation to the religious beliefs of the voters, whether members of Protestant Churches, the Catholic Church, or no church.

(5) The growth of the movement was, in no small measure, due to the personality of such leaders as James H. Maurer, for years President of the Pennsylvania Federation of Labor and Socialist member of the State legislature; to the harmonious relationship between the trade union and the political branches of the labor movement and to the large proportion of industrial workers of homogeneous backgrounds.

(6) The Reading socialists demonstrated that working class political action was possible "within the democratic framework of American culture."

The author draws interesting contrasts between the Reading socialist movement and those in Milwaukee and Bridgeport, which also supported socialist administrators. He brings us face to face with many of the non-statistical human and political problems facing the socialist and radical movement.

Such a scholarly and realistic study is to be welcomed by all who wish to get at the truth concerning the make-up of important minority movements. It is to be hoped that similar sympathetic, unprejudiced studies will be made of political developments in other cities and in the Nation as a whole. They are a wholesome antidote to hysterical misrepresentations which too often develop into social tensions that threaten our democratic institutions.

HARRY W. LAIDLER

Economic Factors in Michigan Delinquency, by Paul Wiers. New York: Columbia University Press. 1944. x, 54 pp. $1.00.

This provocative study "attempts to show what broad community factors influence juvenile delinquency and how much of the difference in the amount

of delinquency from one region of the state to another can be explained by differences in these conditions." The average (of the years 1927, 1928, 1931, and 1932) number of court hearings per 1000 children aged 10–16 years enumerated by the 1930 census was used as a county measure of the incidence of juvenile delinquency. Observing the rather close relation of this rate to population density, the author then stratified the 83 counties on this factor emerging with 19 groups of counties for which average rates of juvenile delinquency were computed. These group averages were used in a correlation analysis with 48 variable measures of social and economic characteristics.

Results showed the closest associations of the rate of juvenile delinquency to be with various measures of urbanization and related factors. Five simple correlations exceeded 0.85. Using the three independent variables, per capita value added by manufacture, logarithm of the number of income tax returns per capita, and the proportion of all males employed, a multiple correlation coefficient of 0.95 was obtained. Factors with little or no significant relation to the rate of juvenile delinquency were population growth, race and nativity, school attendance, and church membership.

The publisher's announcement calls this the first attempt to relate juvenile delinquency to the socio-economic backgrounds of such broad areas as states. This is a bit surprising if true. Although studies of juvenile delinquency have been concerned chiefly with delinquent personalities, some attention has been given to family and community factors, particularly in the urban community. Statistical studies such as that of Mr. Wiers appear to represent a logical extension of those made by the urban social ecologists.

The author is sober and restrained in conclusions and makes no recommendations for social action. He does point out that if juvenile delinquency could be reduced to the rates prevailing under the most favorable conditions of population density and urbanism, two thirds of the state's delinquency would be removed. But would society care to pay the price?

The report is very compact and will scarcely be comprehended by the general reader although in places it appears to have been written for him. The inclusion of a summary table recording the numerous "r's" scattered throughout the text would enhance its usefulness.

C. E. LIVELY

University of Missouri

The Impact of the War on the Financial Structure of Agriculture, by Alvin S. Tostlebe, et al. Washington: United States Department of Agriculture, Bureau of Agricultural Economics. 1944. 191 pp.

This timely and useful publication presents facts on the extent of wartime changes in the financial structure of agriculture, interprets the economic significance of these changes and explains the effect of possible postwar developments on the financial structure of agriculture. A consolidated balance sheet of all farms of the United States is developed as of January 1 for each

year, 1940 to 1944. The balance sheet lists the value in dollars of tangible assets, including real estate, livestock, machinery and equipment, crops and household equipment, and lists intangible assets including currency and deposits, U. S. Savings Bonds, warehouse receipts, and other assets. Under equity items are included the amount of real estate mortgage, non-real estate debts, and proprietor's equity.

During the four years ended January 1, 1944, the dollar value of physical goods in agriculture in the United States increased from 49 billion dollars to 70 billion dollars. If certain intangibles owned by farmers are included, such as cash, deposits, and U. S. Savings Bonds, agriculture grew from a 54 billion dollar to an 83 billion dollar industry. Debts of farmers declined in an amount of nearly one billion dollars and equities of all farmers and farm owners increased to the extent of 30 billion dollars. The farm physical plant showed only limited increase during the four years, and therefore of the increase of 21 billion dollars in the valuation of tangible farm assets, nearly 20 billion dollars is accounted for by the increase in prices. On January 1, 1944, American farmers held currency, deposits and U. S. Savings Bonds totaling 12 billion dollars. On the same date, real estate and other debts of farmers totaled slightly more than 9 billion dollars.

All persons interested in the welfare of agriculture and more particularly in the problem of keeping the industry in a strong financial position will find the analysis and detailed facts on values of farm property, farm indebtedness and farm income of great value. Also of interest is the analysis of the financial structure of agriculture in the postwar period. The probable immediate postwar developments and also the later postwar developments are discussed with reference to their effect on the financial position of farmers.

The authors caution readers against using the financial data for the agricultural industry as a whole in drawing conclusions with respect to particular farms or areas since changes have not been uniform over the country. Also, it is emphasized that much of the data presented are based on estimates. Detailed statements of the methods used in making the estimates are found in the appendix.

Appearing at a time when it is important to curb farm land inflation and maintain agriculture in a strong financial position, the analysis in this publication, including the new facts presented, is an outstanding contribution.

E. C. Johnson

U. S. Department of Agriculture

Selective Factors in Migration and Occupation: A Study of Social Selection in Rural Missouri, by Noel P. Gist, C. T. Pihlblad, and Cecil L. Gregory. Columbia, Missouri: The University of Missouri. 1943. 166 pp. $1.50.

This volume is the result of a study made in the accepted sociological pattern, the purpose of which is contained in the subtitle rather than in the title. The initial concept reflects the authors' faith in the value and usefulness

of regional selectivity studies, and the publication is a contribution to the enlargement of knowledge in that field.

The particular purposes of the study were to examine representative cross sections of rural population in high school years in the 1920's and then to find what chance, fate, geography, and aptitude have done to the different representative fractions of the sample. From the standpoint of identification, the study reflects a considerable amount of arduous and no doubt exhaustive research, both as to individuals and environments. The detailed statistical compilations were derived from the analysis of a 1938 survey of 5,461 persons representative of 97 rural Missouri communities. Basic to the study is the "intelligence" factor, figured on scholastic ratings. By using mean school grade ratings, percentage relationships and ratios of the elements in the sample, the interrelationships were determined in terms of sex, type of community, formal education, the distance they had moved, the sort of work done by the person and his parents.

Some of the findings are interesting, such as the generally superior scholastic achievement of female over male high school students. The social consequence of this index of the superiority of the feminine mind is explained away —but none too satisfactorily.

This, however, was not the gravamen of the study's conclusions. The most interesting deductions were the effects of the educational backgrounds in relation to migration shifts and occupational achievements, the major thesis of the study. The authors found that it made quite a substantial difference in the individual's capacity to grow whether he shifted from a rural environment after high school or after college. Those who had had the energy and opportunity to continue their immersion in education into the more formative years of youth seemed considerably more successful in their later life.

This generalization was in turn conditioned by the type of social stimulation the new environment could contribute to the in-migrants. The authors differentiated the affective influence by such criteria as by the size of the receiving community—farm, small and large villages, small, medium and large cities—and found the greater concentrations of the scholastically superior group in the larger urban areas. The comparisons of village and metropolitan pressures on culture patterns are always interesting. The social and economic repercussions of such transplantings represent major sociological question marks. Attention might also be given to the disintegrating effect of the impersonal urban mass upon personality and group development and differentiation.

HELEN SLENTZ MILTON

St. Louis

Elementary Statistics and Applications, by James G. Smith and A. J. Duncan. New York: McGraw-Hill Book Company, Inc. 1944. x, 720 pp. $4.00.

Considered as an exposition of the chief statistical methods, this volume has much to recommend it. The coverage of topics is adequate, details of

calculation are given in full with attention to the organization of worksheets, and well selected charts illustrate the text. Many minor features will appeal to the careful teacher. Bivariate charts (e.g., morbidity rates as related to age) are presented for what they are, and not as oddly-shaped freguency distributions. The term, guessed mean, is abandoned. The logic of the Doolittle method is made clear. While one may have certain objections to the discussion of methodology (for example, just what mathematical background is assumed?), such defects are for the most part matters that may be remedied, if necessary, in the classroom.

The book, however, should be judged on a different level. With the admirable purpose of showing the student that the subject concerns real and important matters (not "just numbers") the authors have included a considerable amount of interesting historical material. With this good start in the direction of "realism," one wishes that they had followed through with more discussion of concrete issues in the main body of the text. While actual data are used, there is little in the way of comparative analysis. (Even simple problems like the comparison of weekly earnings of men and of women in a given industry help to develop in the student a tendency to "go behind" the arithmetic.) The introduction of more "interpretations" throughout the discussion of methodology would have driven home the point of the historical material and made the book a greater innovation than it is.

Statistical data may form the basis of scientific generalization, and the nature (and limitations) of statistical inference should certainly be emphasized in showing the student "what statistics is about." This section of the discussion (in Part III) treats (a) the elements of the probability calculus, (b) the normal curve in its "binomial" aspect, and (c) certain types of inference, handled on the whole in a very sketchy fashion. While the student will learn many things of use in more advanced study of inference, to which the second volume of the text is to be devoted, one wonders whether this introduction to the subject will give him a clear view of the nature of inference, or any idea of its fundamental role in scientific work.

The defects of the book are largely those of not doing full justice to the sound ideas apparently held by the authors. Certainly, in its present form, it is worthy of careful consideration by prospective users.

Edward E. Lewis

Howard University

Elementary Statistics: with General Applications, by Morris Myers Blair. New York: Henry Holt and Company. 1944. xiv, 690 pp. $3.50.

The author of this textbook believes that most students studying statistics should be thought of as "consumers of statistics instead of creators of researches." With this viewpoint in mind the material is presented in a manner that would require only a minimum knowledge of mathematics. The book could be used for either a one or a two semester course ranging from the

sophomore to the graduate levels. While it is not intended to be an encyclopedia of statistical methods, nevertheless the businessman or statistician would find it a useful reference volume.

The book is divided into five parts. The first part, "General Methods" covers the usual introductory material, such as: the use of statistics, elementary mathematical processes, ratios and percentages, gathering of data, construction of the frequency distribution, tabulation, and graphic presentation.

The second part, "Large Sample Analysis," includes chapters on averages, variation and skewness, linear correlation, sampling, probability and error. This section also includes a chapter on "Tabular Analysis" as a further explanation of relationship.

The analysis of time series and index numbers is discussed in the third part. In the chapter on trend only the simplest equations are illustrated, such as the second degree parabola and the compound interest curve. The logistic curve given in a later chapter might well have been placed under trend.

The link relative and the twelve months moving average methods are the important techniques described for the computation of constant seasonal variation. No methods for computing changing seasonal variation are shown. Cycles are computed by the residual process, and in addition, the method of cyclical computation devised by Wesley C. Mitchell and Arthur F. Burns is discussed at some length. The essential technique of index number construction is given, but there is no discussion of the more prominent index numbers in current use.

Parts four and five include small sample analysis, the analysis of variance and covariance, curvilinear regression, multiple and partial correlation, and a final chapter on types of statistical reports and how they should be prepared. Usually these subjects are considered difficult by most students. However, the large number of "worksheets" plus the detailed explanations should make these sections much easier for the novice to understand.

Other aids to the student will be found in the appendices. The first one contains a list of important formulas used in the book. The second has an alphabetical arrangement of technical terms and their definitions, from abscissa to y-axis. The usual tables of ordinates and areas of the normal curve, relations between r and z are included, as well as a table of squares, square roots and reciprocals to 1,000 and a five-place table of common logarithms from 1 to 10,000.

This book is a welcome addition to the expanding field of statistics. The tools of analysis offered the student are well selected, carefully illustrated with practical problems, and made understandable by the sympathetic attitude of the author.

RAYMOND F. BLACKBURN

University of Pittsburgh

The World's Biggest Business—American Public Spending, 1914–1944, by Paul W. Ellis. New York: National Industrial Conference Board. 1944. 152 pp. $2.00.

This volume is a handbook of statistics in the general field of taxation and government finance. It contains 73 tables, and 17 charts with a commentary discussing the singificance and composition of the tables. Detailed revenue, expenditure, and debt data by types, sources and use on federal, state, and local governments are given as well as long term trends of these financial series. This book will be of much use to both the specialists and general users because it compiles in one volume a great many important and useful figures in the general field of taxation.

In certain tables estimates for 1945 are shown. It would have been appropriate if more detail had been given concerning the assumptions upon which these estimates are based. For example, no indication is given on the national income basis for these estimates, nor is there any indication of whether the estimates are based on the assumption that a part or the entire war will end in 1945 or not.

Most of the analysis of the sources of the data and the implication of the figures are objective. Though this book does not attempt to analyze or evaluate the reasons for the growth of the government debt, in a few places in the commentary, especially at the beginning of the volume, an attempt is made to insert certain implications which may or may not be drawn from the data. For example, general statements are made in a number of places on the bigness of government expenditures and the fact that the huge expenditures once undertaken will maintain themselves. The implication in the first case is that bigness of debt itself is bad, and in the second place that spending just continues on its own momentum. Whether this is true or not cannot be drawn from statistics compiled in this volume nor from the analysis given. Since these statements are only a very small part of the volume they do not detract from the fact that the statistical data in this volume will be extremely useful.

P. Bernard Nortman

Falls Church, Virginia

PUBLICATIONS RECEIVED*

Arnold, Sam. *Planned Dovetailing of Seasonal Employment.* Columbus: The Ohio State University, Bureau of Business Research. 1944. xiii, 51 pp. $1.00.

Burnham, Elizabeth A. *An Analysis of Operating Data for Small Department Stores, 1938–1942.* Boston: Harvard University, Graduate School of Business Administration, Bureau of Business Research. 1944. vi, 42 pp. $1.50.

Bursk, Edward C. *Expenses and Profits of Limited Price Variety Stores in 1943, Chains and Independents.* Boston: Harvard University, Graduate School of Business Administration, Bureau of Business Research. 1944. vi, 38 pp. $1.00.

Butters, J. Keith, and John Lintner. *Effect of Federal Taxes on Growing Enterprises, Study No. 2, Polaroid Corporation.* Boston: Harvard University, Graduate School of Business Administration, Division of Research. 1944. v, 63 pp. 50 cents.

Butz, Earl L. *The Production Credit System for Farmers.* Washington: The Brookings Institution. 1944. vii, 104 pp. $1.00.

Fisher, R. A. *Statistical Methods for Research Workers.* Ninth Edition. London: Oliver and Boyd, Ltd. 1944. xiv, 350 pp. 16 shillings.

Goodman, Gilbert. *Government Policy Toward Commercial Aviation.* New York, Morningside Heights: King's Crown Press. 1944. 122 pp. $1.60.

Gordon, R. A. *Business Leadership in the Large Corporation.* Washington: The Brookings Institution. 1945. xiv, 369 pp. $3.00.

Graham, Benjamin. *World Commodities and World Currency.* New York: McGraw-Hill Book Company. 1944. xii, 182 pp. $2.00.

Harbison, Frederick H. *Seniority Problems During Demobilization and Reconversion.* Princeton: Industrial Relations Section, Princeton University. 1944. 31 pp. 75 cents.

Kraitchik, Maurice. *Alignment Charts, Construction and Use.* New York: D. Van Nostrand Company, Inc. 1944. 94 pp. $2.50.

Milbank Memorial Fund. *Demographic Studies of Selected Areas of Rapid Growth, Proceedings of the Round Table on Population Problems.* New York: Milbank Memorial Fund. 1944. 158 pp. $1.00.

Mosak, Jacob L. *General-Equilibrium Theory in International Trade.* Cowles-Commission for Research in Economics, Monograph No. 7. Bloomington: The Principia Press, Inc. 1944. xiii, 187 pp. $2.50.

Pargellis, Stanley, Ed. *The Quest for Political Unity in World History.* Volume III of the Annual Report of the American Historical Association for the year 1942. Washington: U. S. Government Printing Office. 1944. xiv, 386 pp. $1.00.

Smith, Thomas Russell. *The Cotton Textile Industry of Fall River, Massachusetts, A Study of Industrial Localization.* New York, Morningside Heights: King's Crown Press. 1944. x, 175 pp. $2.00.

Snider, Joseph L. *Excess Profits Tax Relief: The Cyclical Provisions.* Boston: Harvard University, Graduate School of Business Administration, Division of Research. 1944. iv, 30 pp. $1.50.

Teele, Stanley F. *Operating Results of Department and Specialty Stores in 1943.* Boston: Harvard University, Graduate School of Business Administration, Bureau of Business Research. 1944. vi, 35 pp. $2.50.

* Annual reports and publications presenting statistics collected at regular intervals have been omitted from this list. Some items of minor interest to statisticians have also been omitted. The contents of periodical publications are not listed, but the attention of the reader is directed to the lists of articles in current publications which are to be found in the *Revue de l'Institut International de Statistique, Journal of the Royal Statistical Society, American Economic Review, Population Index, Transactions of the Actuarial Society of America, The Record of the American Institute of Actuaries,* and *Sankhyā, The Indian Journal of Statistics.*—Editor.

The American Institute of Accountants. *Termination and Taxes and Papers on other Current Accounting Problems.* New York: The American Institute of Accountants. 1944. vii, 213 pp. $1.00.

The Provident Loan Society of New York. *Fifty Years of Remedial Lending.* Philadelphia: William F. Fell Company. 1944. 52 pp.

The Regional Plan Association, Inc. *The Economic Status of the New York Metropolitan Region in 1944.* New York: The Regional Plan Association, Inc. xx, 91 pp.

Timoshenko, V. P. *World Wheat Production: Its Regional Fluctuations and Interregional Correlations.* Stanford University: Food Research Institute. Vol. 18, No. 7; Vol. 19, No. 5; Vol. 20, No. 6. 1944. 185 pp. $3.00.

Tostlebe, Alvin S., et al. *The Impact of the War on the Financial Structure of Agriculture.* Washington: United States Department of Agriculture, Bureau of Agricultural Economics. 1944. 191 pp.

Van Zandt, J. Parker. *Civil Aviation and Peace.* Washington: The Brookings Institution. 1944. x, 157 pp. $1.00.

Government Publications

Bean, Louis. *Crop Yields and Weather.* Washington: U. S. Government Printing Office. 1944. 131 pp. 40 cents.

Benham, Frederic. *The National Income of Jamaica, 1942.* Bridgetown, Barbados: Advocate Company, Ltd. Development and Welfare in the West Indies, Bulletin No. 5. 29 pp. 10 cents.

Benham, Frederic. *The National Income of St. Vincent, 1942.* Bridgetown, Barbados: Advocate Company, Ltd. Development and Welfare in the West Indies, Bulletin No. 8. 1944. 6 pp. 10 cents.

Benham, Frederic. *The National Income of Barbados, 1942.* Bridgetown, Barbados: Advocate Company, Ltd. Development and Welfare in the West Indies, Bulletin No. 9. 1944. 24 pp. 10 cents.

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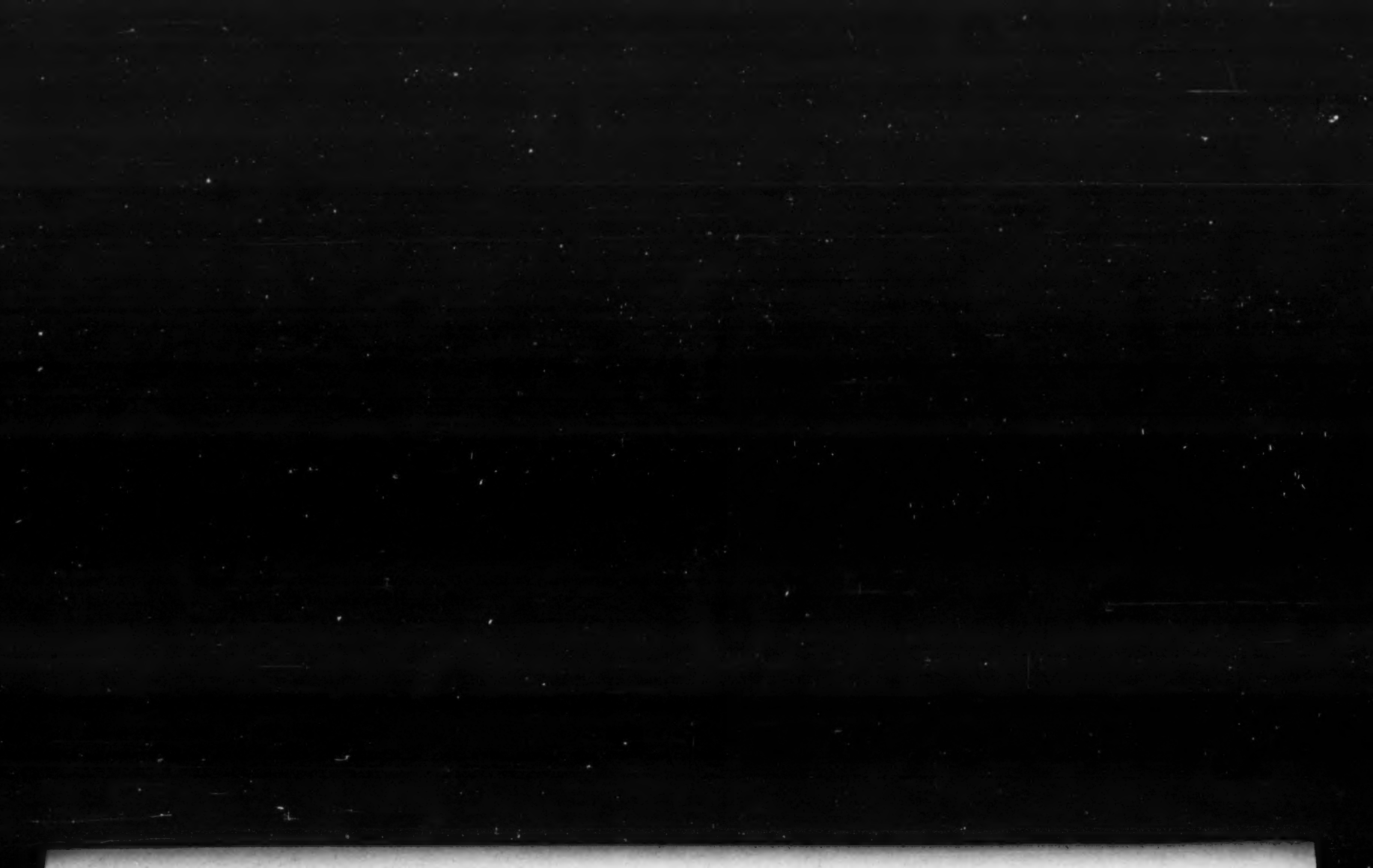
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